This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

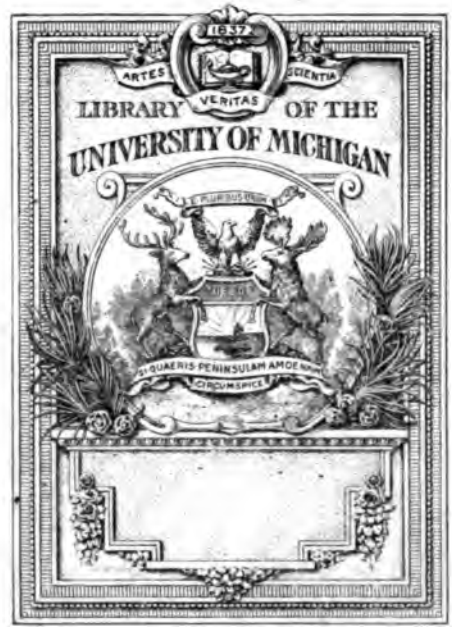
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

B 1,070,745


1837
ARTES
SCIENTIA
VERITAS
LIBRARY OF THE
UNIVERSITY OF MICHIGAN
SI QUAERIS PENINSULAM AMOENAM
CIRCUMSPICE

QH
1
.A15

PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1892.

COMMITTEE OF PUBLICATION.

JOHN H. REDFIELD, EDW. J. NOLAN, M. D.,
THOMAS MEEHAN, ANGELO HEILPRIN,
CHARLES E. SMITH.

EDITOR: EDWARD J. NOLAN, M. D.

PHILADELPHIA:
ACADEMY OF NATURAL SCIENCES,
LOGAN SQUARE.
1893.

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.
February 22, 1893.

I hereby certify that copies of the Proceedings for 1892 have been presented at the meetings of the Academy as follows:—

Pages	9 to 56	March	1, 1892.
"	57 to 104	March	15, 1892.
"	105 to 120	March	29, 1892.
"	121 to 152	April	5, 1892.
"	153 to 168	April	19, 1892.
"	169 to 200	May	17, 1892.
"	201 to 216	June	21, 1892.
"	217 to 232	August	23, 1892.
"	233 to 264	September	20, 1892.
"	265 to 280	October	11, 1892.
"	281 to 320	November	15, 1892.
"	321 to 336	November	29, 1892.
"	337 to 352	January	24, 1893.
"	353 to 400	February	14, 1893.
"	401 to 432	February	7, 1893.
"	433 to 448	February	14, 1893.
"	449 to 496	February	21, 1893.

EDWARD J. NOLAN,
Recording Secretary.

PHILADELPHIA:
BINDER & KELLY, PRINTERS.

LIST OF CONTRIBUTORS.

With reference to the several articles contributed by each.

For Verbal Communications see General Index.

Banks, Nathan. The Spider Fauna of the Upper Cayuga Lake Basin (Plates I, II, III, IV, V) 11

Brown, Amos P. The Development of the Shells in the Coiled Stage of Baculites compressus Say (Plate IX) 136

Chapman, Henry C., M. D. Observations upon the Brain of the Gorilla (Plates XI, XIII) 203

Cope, Edw. D. A Contribution to a Knowledge of the Fauna of the Blanco Beds of Texas 226

The Batrachia and Reptilia of Northwestern Texas 331

Fox, William J. Report on the Hymenoptera Collected in West Greenland. 133

Greene, Edward L. Eclogæ Botanicæ, No. 1 357

Hoffman, Horace Addison, and David Starr Jordan. A Catalogue of the Fishes of Greece, with notes on the names now in use, and those employed by Classical Authors 230

Ives, J. E. A new Species of Pycnogonum from California (Plate X) 142

Keller, Ida A., Ph. D. The Phenomenon of Fertilization in the Flowers of Monarda fistulosa (Plate XV) 452

Meehan, Thomas. Contributions to the Life-Histories of Plants No. 7. (On the Vitality of some Annual Plants; On Self-pollination in Amsonia Tabernæmontana; On a special form of Cleistogamy in Polygonum acre; On the Direction of Growth in Cryptogamic Plants; Tricarpellary Umbellifers; A Mode of Variation in Stellaria media; On the Sexes of the Holly; On the Stamens of Ranunculus abortivus; On the Character of the Stamens in Ornithogalum umbellatum; Note on Barbarea in Connection with Dichogamy.) 160

Contributions to the Life-Histories of Plants, No. 8. (Euphrasia officinalis: Notes on Gaura and Œnothera; The Carpellary Structure of Nymphæa; On the Sexual Characters of Rhus; Rubus chamæmorus; Dalibarda repens; On some Morphological Distinctions in the Genera of Ericaceæ; Vitality of Seeds; Lysimachia atropurpurea; Campanula rotundifolia; Cornus Canadensis; Aralia hispida; Luzula campestris; Cakile Americana; Hypericum ellipticum; Trifolium hybridum; Lathyrus maritimus; Lonicera cœrulea; Raphanus sativus; On the Nature of the Verrucæ in some Convolvulaceæ; Polygonum cilinode; Aster tatarica) 366

Notes on Monarda fistulosa 449

Peary, Robert E. Report of the Operations of the North Greenland Expedition of 1891–1892 342
Pilsbry, H. A. New and unfigured Unionidæ (Plates VII and VIII) 181
On the Anatomy of Sagda, Cysticopsis, Ægista and Dentellaria (Plate XIII) 213
Notes on a Collection of Shells from the State of Tabasco, Mexico (Plate XIV) 338
Preliminary Outline of a new Classification of the Helices 387
Rand, Theodore D., William W. Jefferis and J. T. M. Cardeza, M. D. Mineral Localities of Philadelphia and Vicinity 174
Rhoads, Samuel N. The Birds of Southeastern Texas and Southern Arizona observed during May, June and July, 1891 98
Ryder, John A. On the Mechanical Genesis of the Scales of Fishes 219
The Principles of the Conservation of Energy in Biological Evolution: a Reclamation and Critique 455
Scott, W. B. A Revision of the North American Creodonta, with notes on some Genera which have been referred to that Group 291
The Evolution of the Premolar Teeth in the Mammals 405
Skinner, Henry, M. D., and Levi W. Mengel. Greenland Lepidoptera 156
Stone, Witmer. Birds Collected by the West Greenland Expedition 145
Walker, Ernest. The Autosporadic Seeds of Oxalis stricta 288
Wistar, Isaac J. Remarks on the Quantity, Rate of Consumption and probable Duration of North American Coal, and the consequence to Air-breathing Animals of its entire Consumption 82
Wright, G. Frederick. Extra-Morainic Drift in the Susquehanna, Lehigh and Delaware Valleys 469

Peary, Robert E. Report of the Operations of the North Greenland Expedition of 1891–1892 542
Pilsbry, H. A. New and unfigured Unionidæ. Plates VII and VIII 15
On the Anatomy of Sagda, Centrocapsa, Sigapia and Incertilucra. Plate XIII 213
Notes on a Collection of Shells from the Shore of Tamaulipas, Mexico. Plate XIV 226
Preliminary Outline of a new Classification of the Helices 257
Rand, Theodore L., William W. Jefferis and J. T. M. Cardeza, M. D. Mineral Localities of Philadelphia and Vicinity 174
Rhoads, Samuel N. The Birds of Southeastern Texas and Southern Arizona observed during May, June and July, 1891 98
Ryder, John A. On the Mechanical Genesis of the Scales of Fishes 239
The Principles of the Conservation of Energy in Biological Evolution: a Recitation and Critique 455
Scott, W. B. A Revision of the North American Canidæ, with notes on some Genera which have been referred to that Group 291
The Evolution of the Premolar Teeth in the Mammalia 405
Skinner, Henry, M. D., and Lewi W. Mengel. Generalized Lepidoptera 156
Stone, Witmer. Birds Collected by the West Greenland Expedition 145
Walker, Ernest. The Astrosporidic Seeds of Caulerpa utricularia 206
Wister, Isaac J. Remarks on the Quantity, Rate of Consumption and practicable Duration of North American Coal, and the consequence to Americans of its entire Consumption 82
Wright, G. Frederick. Extra-Glacial Drift in the Susquehanna, Lehigh and Delaware Valleys 486

PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1892.

JANUARY 5, 1892.

The President, GEN. ISAAC J. WISTAR, in the chair.

Three hundred and eighty persons present.

The death of Edward K. Tryon, a member, January 2, was announced.

The Council reported that the following Standing Committees had been appointed to serve during the ensuing year:—

ON LIBRARY.—W. S. W. Ruschenberger, M. D., Henry C. Chapman, M. D., Gavin W. Hart, Charles P. Perot and J. Bernard Brinton, M. D.

ON PUBLICATIONS.—John H. Redfield, Charles E. Smith, Angelo Heilprin, Thomas Meehan and Edward J. Nolan, M. D.

ON INSTRUCTION AND LECTURES.—Charles Morris, Isaac C. Martindale, Harold Wingate, Geo. A. Rex, M. D. and J. Bernard Brinton, M. D.

STANDING COMMITTEE OF COUNCIL ON BY-LAWS.—W. S. W. Ruschenberger, M. D., Theodore D. Rand, Isaac C. Martindale and Isaac J. Wistar.

Mr. H. G. BRYANT, by invitation, delivered an address on his recent journey though Labrador to the Grand Falls. (No abstract).

JANUARY 12.

The President, GEN. ISAAC J. WISTAR, in the chair.

Fifty-four persons present.

A paper entitled "Report on the Hymenoptera collected in West Greenland," by Wm. J. Fox, was presented for publication.

The President, having resigned the chair to Mr. Meehan, read a paper entitled "Remarks on the quantity, rate of consumption and probable duration of North American Coal and the consequences to air-breathing animals of its entire combustion" which was then presented for publication.

JANUARY 19.

Mr. CHARLES MORRIS in the chair.

Twenty-eight persons present.

JANUARY 26.

The President, GEN. ISAAC J. WISTAR, in the chair.

One hundred and thirty-seven persons present.

A paper entitled "Observations upon the brain of the Gorilla" by Henry C. Chapman M. D., was presented for publication.

The REV. R. H. NASSAU, by invitation, made a communication on the natural history of the Gorilla and on the capture of the specimens in the collection of the Academy. (No abstract).

A resolution was adopted authorizing the sending to Greenland of a Peary Relief Expedition and appointing Prof. Angelo Heilprin leader of the same.

The following were elected members:—James D. Winsor, James S. de Benneville, Charlemagne Tower, Jr., H. H. Furness, Jr. Theo. P. Matthews, Joseph P. Remington, Thomas C. Price, Charles Liebeck, Charles W. Johnson, Benjamin Chew Tilghman, Joseph W. Hawley, J. E. Ives and A. Jahn.

The following were ordered to be printed:—

THE SPIDER FAUNA OF THE UPPER CAYUGA LAKE BASIN.

BY NATHAN BANKS.

In the list given below are contained all the species of spiders known to occur in or near Ithaca. The region examined has no exact limits. It may best be defined as the Upper Cayuga Lake Basin. It embraces the country drained by the streams which flow into the head of the Cayuga Lake. The shores of the Lake have been examined only for a short distance: on the west side for ten miles to Traghanic; on the east about four miles to Burdick's Glen. A large share of the collecting has been done in the beds of the gorges and in the swamps. Of these, those most carefully examined are as follows: of the gorges, Fall, Cascadilla, Six Mile and Buttermilk Creek; of the swamps, Inlet Marsh, Beebe Island and South Hill Marsh. Collecting in the other localities has not been so thorough. The collecting began in the spring of 1888 and has lasted about two years. From these facts it may be seen that the list is not at all complete.

The collecting has been done chiefly by myself although others have occasionally given me specimens. To them I am deeply indebted, both for the specimens and for the encouragement they have shown me. Those who have especially aided me are Mr. G. Van Ingen, Mr. H. Hicks, Mr. A. D. MacGillivray, Mr. H. W. Norris and Mr. Brace.

To Prof. L. M. Underwood, of Syracuse University, I am under the deepest of obligations. Were it not that he kindly lent me much literature on the subject, this paper could not have been written. To the Rev. Dr. H. C. McCook, of Philadelphia, I wish to express my thanks for the work done upon the Epeiridæ. To J. H. Emerton I am deeply indebted for much help in determining several species, and to Prof. J. H. Comstock, under whose direction the paper has been written, for much kindly assistance and encouragement.

The country is very diversified, low lands and high hills, marshes, creeks forming beautiful gorges, bare rocky cliffs and mud-bottoms. The climate is as varied as the country. These facts, with its flora and insect fauna, account for the large number of spiders. Diversity of country is of course more favorable to ground spiders than to web-building ones; so it will be noticed that the pro-

portion is greater in the Lycosidæ than in the Epeiridæ when compared with the New England fauna.

Several bibliographies of American spiders are easily accessible. The American Naturalist for November, 1887, contains a quite complete one by Prof. Underwood. Bulletin No. 19 of the U. S. Department of Agriculture also contains a list of the more important works. Many of the early descriptions are worthless and may never be identified. I have not thought Walckenaer's names worth using. Some of Hentz's species will probably never be determined. Some later writers have occasionally been careless in describing species.

The list here submitted will compare favorably with others, as may be seen by the following:—

Cayuga Lake, by Banks, (1890)	363	species
Great Britian, by Cambridge, (1874)	457	"
Sweden, by Westring,	308	"
Italy,	404	"
France, by Simon, (1874) about,	1000	"
Austria, by Doleschal, (1867)	205	"
Prussia, by Ohlert, (1867)	188	"
Tyrol, (1867)	233	"
Vicinity of Prague, by Prach, (1866)	119	"
Spiders of Trent, by Canestrini, (1875)	243	"
Catalogue of Spiders of Switzerland, by Pavesi, (1875)	285	"
Spiders of Westphalia, by Karsch, (1874)	154	"
South Russian Spiders, by Thorell, (1875)	303	"

Emerton has published lists of the New England forms of seven families; they compare with the Ithaca fauna as follows:—

	New England.		Ithaca.	
Lycosidæ,	33	species.	42	species.
Epeiridæ,	51	"	43	"
Theridiidæ,	137	"	124	"
Ciniflonidæ,	16	"	14	"
Drassidæ,	34	"	43	"
Agalenidæ,	11	"	17	"
Dysderidæ,	2	"	0	"

It will be seen from these comparisons that the vicinity of Ithaca is a very fertile locality for spiders.

Classification is only possible when many links are lost. Among the spiders as they exist in this locality certain groups are quite definite, while others are closely related. The Lycosidæ and Attidæ are distinct both from each other and from the other families. The Thomisidæ are also easily separated. The Epeiridæ and Theridiidæ can be separated, yet *Meta* is almost as

near to one as to the other. But the Drassidæ, Agalenidæ and Ciniflonidæ are very closely related to each other and to the Theridiidæ. I have not thought the Ciniflonidæ a group of sufficient distinctness to be recognized as a family. The existence of a calamistrum and cribellum in *Hypochilus thorelli* shows that this character does not indicate close relationship. And besides, the Ciniflonidæ comprises two well-defined sub-families, one of which may be near the Epeiridæ and the other is very close to the Agalenidæ. So I have divided the Ciniflonidæ and placed them in these two families.

Still it may sometimes be necessary to use artificial characters for a division. I have separated the Drassidæ and Agalenidæ according by the number of tarsal claws. Some species which have been classed as Agalenidæ may, by the division, fall into the Drassidæ; yet the two families are so closely related that such forms will not mar, to any great extent, the similiarity of structure of the Drassidæ.

The Attidæ appear to be very high if not the highest. The Drassidæ, I think, are the lowest. The Epeiridæ were probably developed from the Theridiidæ, the Theridiidæ from the Agalenidæ and these from the Drassidæ.

As I have not had access to several important European works, the sequence of genera adopted is merely provisional, and I have not felt at liberty to introduce changes in classification. Not all the material obtained has been described; this is especially the case with certain young forms, which have been left with the hope of getting the adult stage.

KEY TO FAMILIES.

1.	Lung slits four, or two lung slits and two spiracles just behind them,	2
	Lung slits two, the spiracles not just behind them; mandibles articulated vertically,	4
2.	Eyes eight,	3
	Eyes six,	DYSDERIDÆ.
3.	With extra spinning organs,	HYPOCHILIDÆ.
	Without extra spinning organs,	MYGALIDÆ.
4.	Eyes equal or subequal, in two rows,	6
	Eyes eight, unequal, in three or four rows,	5
5.	Eyes in three or four rows; if three rows, two middle of first row largest, second row smallest; if four rows, first row largest, third row smallest,	ATTIDÆ.
	Eyes in three or four rows, first row of four or two small eyes, second or third row of large eyes,	LYCOSIDÆ.

6. Tarsi with two claws, no web, 7
   Tarsi with three claws, usually a web, 8
7. Second pair of legs as long or longer than the fourth, all eyes diurnal, THOMISIDÆ.
   Second pair of legs not so long as fourth, only anterior M. E. diurnal, DRASSIDÆ.
8. Hind spinnerets longer than others and of two joints[1]; or else extra spinning organs and anterior eyes equal and the front S. E. colorless, AGALENIDÆ.
   Hind spinnerets of but one joint; when extra spinning organs are present then front S. E. are smaller than front M. E. and dark in color, 9
9. Inner angle of maxillæ rounded, else with extra spinning organs, with an orb web, EPEIRIDÆ.
   Inner angle of maxillæ not rounded, with an irregular web, THERIDIDÆ.

DRASSIDÆ.

Micaria longipes Em.

Rare. Heustis St. and Fall Creek, Aug.

Micaria formicoides, nov. sp. Plate I, fig. 51.

Total length,	♀		4·9mm.
Length of cephalothorax	2· mm.	breadth	1· mm.
Length of abdomen	2·9 mm.	breadth	1·5mm.
Length of sternum	1·05mm.	breadth	·7mm.
Length of femur I	1·2 mm.	tibia I	1· mm.
Length of femur IV	1·7 mm.	tibia IV	1·3mm.

Cephalothorax dark yellow-brown, with a large V-shaped mark at end of cephalic portion; behind this the thoracic part is veined with golden metallic scales. Cephalic part darker, near eyes covered with iridescent scales; hair brownish. Mandibles yellow-red-brown, lighter at apex; basal joints of palpi similar, distal joints light yellow; mouth parts and sternum red-brown with scattered long white hairs. Coxæ light yellow-brown, hind ones lightest; trochanter similar but with a dark stripe before and behind. Femora I and II yellow-brown, darkest at base; other joints light yellow with scattered white hairs and many brown scale-like spines. Coxæ III and IV with a patch of white scales above; femora red-brown, other joints lighter. Femur III with three stripes of white scales one above, one in front, and one behind; femur IV with one white stripe above; patella and tibia III and IV with a white stripe of scales above. Abdomen dark, covered with iridescent scales above and below; near base a broadly interrupted band of white,

[1] This point is difficult to see in *Cybæus*.

behind this the scales are somewhat golden or dark brown according to the light. Near the middle of the abdomen there is on each side a patch of white, behind this the scales are dark-brown or golden according to the light. The apical third of abdomen is black or nearly colorless according to the light. Sides are golden or brown, with a white oblique band at constriction of abdomen. Venter with bright colored scales, in certain light the basal ones are reddish-purple, the apical ones golden. Hairs long, dark, scattered. Epigynum reddish, spinnerets dark red-brown. Cephalothorax highest in middle; sternum sharp-pointed behind, rounded in front, widest at second coxæ. Abdomen with a deep transverse furrow somewhat in front of middle, and which does not intersect the upper side margin; a slight constriction in the sides at the same points; epigynum as figured.

Rare. 14th Sept. Fall Creek on *Solidago* with reddish ants of same size, which it greatly resembles.

Thargalia agilis, nov. sp. Plate I, fig. 52 and 52a.

Total length	♀		9·4mm.
Length of cephalothorax	3·6mm.	breadth	2·5mm.
Length of abdomen	6· mm.	breadth	3·6mm.
Length of sternum	1·9mm.	breadth	1·3mm.
Length of femur I	2·7mm.	tibia I	2· mm.
Length of femur IV	3· mm.	tibia IV	2·7mm.

Cephalothorax jet black with a few white plumose hairs; mandibles dark reddish-brown; sternum brownish-black; labium and maxillæ reddish-brown, whitish at tips; palpi reddish-brown; all coxæ reddish-brown; all femora darker brown; other joints of first and second pairs of legs light yellow-brown; other joints of hind two pairs as dark as the femora, except the tarsi which are lighter. Abdomen black, shining, with scattered whitish plumose hairs, more reddish beneath with hairs more numerous and less plumose; spinnerets dark. Cephalothorax not much higher in middle than in front; rounded in front and behind; upper row of eyes procurved; lower row nearly straight; M. E. of upper row nearer S. E. than each other; same with lower M. E.; quadrangle of M. E. higher than broad; maxillæ convex; labium ⅓ length of maxillæ; epigynum as figured; no spine on front side of fourth hind patellæ.

Not uncommon. Six Mile Creek.

Thargalia perplexa, nov. sp. Plate I, figs. 53, 53a, and 53b.

Total length	♀		8· mm.
Length of cephalothorax	3·3mm.	breadth	2·3mm.

Length of abdomen	4·6mm.	breadth	2·9mm.
Length of sternum	1·8mm.	breadth	1·2mm.
Length of femur I	2·1mm.	tibia I	1·8mm.
Length of femur IV	3· mm.	tibia IV	2·4mm.

Cephalothorax uniform reddish-brown with a few scattered white plumose hairs; mandibles more reddish; mouth parts light reddish-brown, whitish at tips, sternum similar to mandibles; coxæ yellow-brown, first pair darkest; palpi brown at base, yellowish towards apex; all femora red-brown, those of III and IV with some whitish hairs; other joints of I and II light; the tibia a little greenish, tarsus a little brownish; tibiæ and patellæ III and IV similar to femora, tibia a little lighter at extreme tip; metatarsus darker; tarsus lighter. Abdomen red-brown, with many plumose hairs, usually black, but two spots and a band at base white, also some white scattered over middle of dorsum, and an apical band white; venter red-brown with black hairs not plumose; spinnerets red-brown; epigynum reddish. Upper row of eyes procurved, equal in size and at equal distances; lower row almost straight, shorter than upper, M. E. nearer S. E. than to each other; the four M. E. make a quadrangle wider behind than in front and much higher than wide. Hind legs very long. Male similar in color, much smaller, 6mm. long; the abdomen narrower than the cephalothorax; epigynum and palpal organ as figured.

Uncommon.

Thargalia fallax, nov. sp. Plate I, fig. 54.

Total length	♂		7·2mm.
Length of cephalothorax	3· mm.	breadth	2·3mm.
Length of abdomen	4· mm.	breadth	2· mm.
Length of sternum	1·2mm.	breadth	1· mm.
Length of fumur I	2· mm.	tibia I	1·8mm.
Length of femur IV	3· mm.	tibia IV	2·7mm.

Color of cephalothorax a uniform dark red-brown, with a few plumose yellowish hairs; mandibles and palpi same color; mouth-parts red-brown, the tips whitish; sternum black with yellow-brown hairs; coxæ red-brown, first pair darkest; femora nearly black with black hairs; other joints of I and II reddish-yellow; other joints of III and IV red-brown. Abdomen above nearly black at base, growing more red beyond till near apex it is quite bright red, with some yellow plumose hairs; sides black; venter

red-brown with black hairs; spinnerets red-brown. Eyes as in *T. perplexa;* venter with a large median quadrangular sunken space, ♂ palpi as figured.

Two specimens in field below University.

Thargalia bivittata Em.

Frequent in Six Mile Creek often among ants which it resembles, Sept.

Thargalia crocata Hentz.

Rare, one specimen, in field near the University barn.

Prosthesima rufula, nov. sp. Plate I, fig. 55 and 55a.

Total length	♀		5·9mm.
Length of cephalothorax	2·45mm.	breadth	1·7mm.
Length of abdomen	3·5 mm.	breadth	2· mm.
A larger ♀ total length	7· mm.	length of cephalo.	2·5mm.

Cephalothorax nearly uniform reddish, the marginal seam blackish; mandibles similar, sternum more yellow in center and red-brown on sides; lip red; maxillæ yellowish; legs red-brownish yellow; epigynum red; under spinnerets light, upper ones nearly black, abdomen above and below blue-black or blackish; venter with two narrow converging white lines. Upper row of eyes scarcely longer than lower and a little procurved; the upper M. E. large and oblique; a little black around the lower M. E. Head much narrowed; body and legs covered with black hairs; lower spinnerets the longest.

The cocoon of this species is attached to the under side of stones; it consists of two circular sheets of silk between which are placed the eggs. The outer sheet is often covered with dirt or mud so as to resemble the stone.

Frequent. Sept., Oct., Fall Creek, South Hill, Heustis St.

Prosthesima frigida, nov. sp. Plate I, fig. 56, 56a.

Total length	♀		4·6mm.
Length of cephalothorax	1·9mm.	breadth	1·3mm.
Length of abdomen	2·7mm.	breadth	1·5mm.

Male about the same size. Cephalothorax brownish-yellow; seam black; mandibles similar; a little black around eyes; a small V-shaped blackish mark just in front of dorsal groove; basal joints of legs and palpi very light, nearly white; distal joints redder; sternum yellowish, darker on sides; epigynum reddish, surrounded by black; lower spinnerets lighter than upper; abdomen above and

below blackish; ventral lines nearly parallel; body covered with black hairs. Epigynum and palpal organs as figured; eyes as in *P. rufula*; cephalothorax widest behind the middle, head much narrowed.

Several specimens, under a stone near Fall Creek, Feb.

Prosthesima immaculata, nov. sp. Plate I, fig. 58 and 58a.

Total length	♂		6·1mm.
Length of cephalothorax	2·3mm.	breadth	2·8mm.
Length of abdomen	3·8mm.	breadth	2·2mm.

Cephalothorax and mandibles brownish-yellow; legs and palpi paler; sternum yellow, darker on edges; epigynum reddish surrounded by gray; lower spinnerets longer and lighter colored than upper ones; abdomen above and below dark gray; ventral lines wanting; body and legs with blackish hairs; a few white hairs on abdomen. Upper side of coxæ with many bristles; eyes as usual; a little black in lower row; epigynum as figured.

Rare. Sept., Fall Creek.

Prosthesima blanda, nov. sp. Plate I, fig. 57 and 57a.

Total length	♂		7· mm.
Length of cephalothorax	3mm.	breadth	2·1mm.
Length of abdomen	4mm.	breadth	2· mm.

Cephalothorax brownish-yellow; mandibles darker; sternum red brownish-yellow; lip very dark and maxillæ lighter; legs and palpi pale yellowish, brighter toward the tips; abdomen white above and below; spinnerets similar; lung plates yellow; two ventral lines grayish; a yellowish spot at base of dorsum; base of abdomen densely clothed with stiff bristles; body and legs with black hairs; upper row of eyes straight, no longer than lower; palpal organ as figured.

One specimen.

Prosthesima atra Hentz.

A few specimens which probably belong to this species, from Fall Creek.

Prosthesima depressa Em.

Not uncommon. Fall Creek, Six Mile Creek, Oct.

Prosthesima ecclesiastica Hentz.

Frequent; often under bark in winter.

Prosthesima minima, nov. sp. Plate IV, fig. 69.

Length ♀ 2·8mm.

Cephalothorax dull yellowish-brown; legs pale, a little tinge of greenish and brownish; eyes with black rings; sternum nearly white, a little brownish, edge with stiff black hairs. Abdomen above and below pure white, with black hairs which arise from pinkish dots; epigynum reddish; spinnerets white, and projecting beyond end of abdomen. Cephalothorax widest behind the middle, narrow in front; abdomen truncate at base, rounded behind; epigynum small as seen in figure.

One specimen under a stone in Six Mile Creek, March 19.

Poecilochroa montana Em.

One specimen, 24 March. Buttermilk Creek.

The cephalothorax nearly black as are the femora of the legs; the rest of the legs a much lighter brown. Received from Mr. MacGillivray.

Poecilochroa bilineata Hentz.

Uncommon; under stones in Fall Creek.

Gnaphosa brumalis Thor.

Not common.

Gnaphosa conspersa Thor.

Common under stones.

Gnaphosa humilis, nov. sp. Plate I, fig. 59.

Total length	♀		13· mm.
Length of cephalothorax	5·2mm.	breadth	3·9mm.
Length of abdomen	7·8mm.	breadth	4·7mm.
Length of sternum	2·6mm.	breadth	2·1mm.

Cephalothorax reddish brown with long black hair and short pubescence; mandibles darker; sternum lighter; legs like sternum; abdomen colored as usual. Cephalothorax longer than tibia and patella IV; two spines at apex of tibiæ I and II on under side, one or two on tibia II near the middle; epigynum as figured.

This may be the *G. scudderi* Thor. which Emerton considers identical with *G. brumalis* Thor. I think my specimens are distinct from this latter species. Infrequent.

Drassus saccatus Em.

Frequent under stones. South Hill, Six Mile Creek, Sept., Oct.

Drassus humilis, nov. sp. Plate I, figs. 60 and 60a.

Total length	♀		8·9mm.
Length of cephalothorax	3·9mm.	breadth	2·7mm.
Length of abdomen	5· mm.	breadth	2·5mm.

Cephalothorax and mandibles brownish yellow; seam black; a little black around the eyes; sternum brownish-yellow in center, darker on sides; lip darker; maxillæ yellow-brown; epigynum reddish surrounded by yellow; venter light grayish with black hairs; spinnerets yellowish; legs pale yellowish; dorsum dark gray with several lighter chevrons and two spots near base, these are most distinct when wet; dorsum with black hairs; epigynum as figured; upper row of eyes procurved and longer than lower row which is straight; abdomen very low and flat, broadest at middle, pointed behind; legs moderately long and slender.

Frequent under stones. South Hill. Aug.

Clubiona obesa Hentz. Plate I, fig. 61.

Length	♀		9mm.
Length of cephalothorax	3mm.	breadth	2mm.

Cephalothorax pale yellowish; mandibles darker yellow-brown; legs white; sternum pale, with four dark spots on the sides, one at the base of each of the four hind coxæ; abdomen pale pinkish, darkest above and with a darker median stripe which reaches to the middle of the abdomen; spinnerets white; epigynum as figured.

One specimen.

Clubiona tibialis Em. Plate I, fig. 62.

Large ♀, total length			7·7mm.
Length of cephalothorax	3·2mm.	breadth	2·1mm.
Length of abdomen	4·5mm.	breadth	2.1mm.

Small ♀ is 6·1mm. long; cephalothorax 3mm. long.

Very similar to what I have called the female of *C. crassipalpis* Em. The cephalothorax yellow-brown, black in eye-region and on clypeus; mandibles and mouth-parts black; sternum yellowish, with reddish spots on sides; legs like sternum; venter similar; dorsum of abdomen more red-brown, lighter at base. Epigynum very broad as in figure; clypeus very low; mandibles very much projecting in front of cephalothorax; eye-region broad and low; body with white hairs; legs with both white and black hairs.

Two specimens from Inlet Marsh, Aug. The cocoon consists of two sheets of silk connecting the edges of a blade of a large grass. The eggs are placed in an inner case between the two sheets of silk.

The mother watches the cocoon.

Clubiona crassipalpis Keys. Plate I, fig. 63.

One specimen which I have thought may be the female of this species.

Clubiona canadensis Em.

Common, often under bark.

Clubiona pygmea, nov. sp. Plate I, fig. 64.

Total length	♀		3·2mm.
Length of cephalothorax	1·4mm.	breadth	1· mm.
Length of abdomen	1·8mm.	breadth	1·2mm.

Similar in appearance to *C. rubra* Keys. Head a little darker than in that species; eye-rows not so long and eyes a little smaller; dorsum of abdomen with same spear-shaped mark and beyond this reddish; rest white; legs and sternum and venter paler whitish, sternum dark-edged; spinnerets darker than venter; abdomen a little narrower than *C. rubra;* epigynum quite different from that species as seen in figure; black bristles at base of abdomen not so prominent as in *C. rubra.*

One specimen under bark. Nov., Fall Creek.

Clubiona rubra Keys.

One specimen, Fall Creek. Febr.

Clubiona abbotti Koch. Plate I, figs. 65 and 65a.

This species is very close to *C. rubra,* Keys. The epigynum is about the same shape, the cavities are quite distinct, more so than in my specimen of *C. rubra;* the ♂ palpi are also similar to that species. The coloring is the same, except the cephalothorax is a little darker and the mandibles sometimes nearly black; abdomen in one specimen wholly gray, but usually with the red basal stripe and the red tip to abdomen. The smallest ♂ is 4 mm. long; the smallest ♀ is almost 5 mm.; others are larger. The femur of the ♂ palpus has two spines near the tip as seen in figure.

Frequent. Fall Creek, Inlet Marsh.

Clubiona lenta, nov. sp. Plate I, fig. 66.

Total length	♀		4· mm.
Length of cephalothorax	1·3mm.	breadth	9·5mm.
Length of abdomen	2·7mm.	breadth	1·5mm.

Cephalothorax brownish-yellow, darkest in front; mandibles similar but darker; legs and palpi whitish-yellow; sternum and maxillæ similar, former with red-brown edges and joints; lip darker; abdomen brownish-drab with a very faint trace of a redder

median basal stripe on dorsum; color made up of darker and lighter spots; spinnerets yellow; epigynum reddish, two distinct cavities close together; eyes occupying almost the whole of the front of the cephalothorax; legs with black spines and fine black hairs; abdomen with white hairs; bristles at base of abdomen not prominent.

One specimen, Fall Creek, Sept.

Clubiona americana Em.

This is the *C. ornata* Em. 1890, which is preoccupied by Thorell in 1875.

Common, often under bark in cases.

Clubiona excepta Koch.

Frequent, Primrose Cliffs, Beebe Island.

Trachelas tranquilla Hentz (*ruber* Keys).

Clubiona tranquilla Hentz.

Not uncommon, Cascadilla Creek, Six Mile Creek.

Anyphæna incerta Keys.

Uncommon, Indian Spring, Buttermilk Creek, Fall Creek, Nov., Feb., March.

Anyphæna saltabunda Hentz.

Uncommon, Six Mile Creek, Enfield Creek, Sept.

Phrurolithus minutus, nov. sp. Plate I, figs. 67, 67a and 67b.

Total length	♀		2·1 mm.
Length of cephalothorax	·95mm.	breadth	·95mm.
Length of abdomen	1·25mm.	breadth	·7 mm.

Cephalothorax bright yellow with a black stripe each side, which meet behind, and in front through the eye-region; extreme margin also black; abdomen yellowish white with black chevrons; sternum and venter yellowish white; legs yellowish, the first tibia and patella black; epigynum reddish; cephalothorax as broad as long, very low; abdomen long; the two cavities of the epigynum are close together at base and diverge, so that they are much separated behind, while in *P. pugnatus* they are closer together at the caudal part than at cephalic.

Occasional. Fall Creek, Buttermilk Creek, Sept.

Phrurolithus pugnatus Em.

Frequent under stones. Fall Creek.

Phrurolithus palustris, nov. sp. Plate I, fig. 70.

Total length ♀ 2·5–2·8mm.

Cephalothorax yellowish, with dark stripe each side connected behind; margin black; eyes on black; sternum and legs similar to cephalthorax, first tibia and patella a little darker; abdomen with blackish gray markings, spots on base of dorsum sometimes run together, and behind these, chevrons interrupted or sub-interrupted on sides; venter with a few dark spots near spinnerets and two in front of these; epigynum reddish, as figured; cephalthorax broad.

Two specimens, Indian Spring.

Phrurolithus alarius Hentz.

Frequent under stones.

Agrœca pratensis Em.

Common in autumn and winter under leaves.

Agrœca ornata, nov. sp. Plate I, figs. 68 and 68a.

Total length	♀		4·6mm.
Length of cephalothorax	2· mm.	breadth	1·7mm.
Length of abdomen	2·6mm.	breadth	1·4mm.

Cephalothorax light yellowish, with faint blackish lines radiating from the dorsal groove, hem black; mandibles, palpi, mouth-parts, sternum and legs, all light yellowish, the sternum a little brownish on sides. Abdomen light yellow-brown, on hinder part of dorsum two rows of short transverse brown spots, sides with some brown spots and short stripes; venter immaculate; epigynum reddish; spinnerets light; eyes surrounded by black; a faint light-brown median stripe on basal part of dorsum.

Rare. Buttermilk Creek.

AGALENIDÆ.

Agalenineæ.

Cybæus giganteus, nov. sp. Plate I, fig. 71. Plate V, fig. 71.

Total length	♀		11·5mm.
Length of cephalothorax	5mm.	breadth	3·4mm.
Lenth of abdomen	7mm.	breadth	4·9mm.

Cephalothorax dark red-brown, shining; mandibles similar; legs and palpi a little lighter; under side of coxæ yellow-brown; sternum yellow-brown in center, darker and reddish-brown on sides; mouth-parts reddish-brown with tips lighter; venter gray; lung-plates lighter; epigynum reddish; spinnerets yellowish; dorsum

and sides dark grayish-black, with a short, median, basal, light stripe, not reaching to the middle of the dorsum, and each side of this two oblique light spots. Abdomen covered with short black hairs. Upper row of eyes nearly straight, lower recurved, so that the S. E. are closer together than the M. E.; mandibles strongly convex and projecting in front of head; head high and arched; median groove short; from it radiate several grooves to the sides, which at the bottom are a little darker than the surrounding space; lip more than half length of maxillæ, truncate at tip; sternum broad in front, pointed behind between hind coxæ; legs moderately long, with many not very long, appressed, bristly, black hairs, and longer black spines; four pairs of spines on under side of tibia I and II; three pairs on under side of tibia III and IV; abdomen large and thick; widest a little beyond the middle; epigynum as figured; hinder spinnerets not longer than front ones and furnished with tubules only at the tip.

One specimen.

Cœlotes medicinalis Hentz.

Not common.

Cœlotes fidelis, nov. sp. Plate I, fig. 72. Plate V, fig. 72.

Total length	♀		10·9mm.
Length of cephalothorax	4·9mm.	breadth	3·2mm.
Length of abdomen	6· mm.	breadth	3·9mm.
Total length	♂		8· mm.

Very similar to *C. lamellosus* Keys.

Cephalothorax yellow-brown with radiating lines; head darker; mandibles red-brown; mouth-parts red-brown, sometimes lighter at tips; sternum, legs and palpi yellow; sternum with dark edges; legs with indistinct dark rings on femora; abdomen nearly white, with many dark spots and lines most numerous on dorsum, not so numerous, however, as in *C. longitarsus* and *C. altilis;* mandibles not so much projecting as in those species; epigynum and palpal organs as figured. Many specimens, all very constant in shape of the epigynum, which is quite different from *C. lamellosus.*

Common in woods.

Cœlotes longitarsus Em. Plate IV, fig. 73.

The ♂ agrees with Emerton's description and figures. What I take to be ♀ is different from his ♀.

Not uncommon under leaves in autumn and winter.

Total length	♀		8· mm.
Length of cephalothorax	3·85mm.	breadth	2·1mm.
Length of abdomen	4·2 mm.	breadth	2·5mm.

The coloring is similar to the ♂ ; the epigynum as figured.

Cœlotes altilis, nov. sp. Plate I, fig. 74. Plate IV, fig. 74a.

Total length	♀		13·2mm.
Length of cephalothorax	6· mm.	breadth	3·5mm.
Length of abdomen	7·2mm.	breadth	4·9mm.

Cephalothorax yellow-brown; head darker reddish-brown; mandibles similar; cephalothorax with a few radiating darker stripes; mouth-parts red-brown, light at tips; sternum yellow-brown, darker on edges; under side of coxæ and femora light yellow-brown, rest of legs and palpi brighter yellow-brown, distal joints darkest; epigynum reddish; spinnerets yellowish; abdomen light gray, thickly covered above and on the sides with dark spots, and a few scattered spots on venter; on median line of dorsum the dark so arranged as to leave several white chevrons; abdomen with short black hair; differs from *C. montanus* in shape of epigynum.

Frequent in autumn and winter under leaves.

Cœlotes lineatus, nov. sp.

Total length	♂ juv.		8·5mm.
Length of cephalothorax	3·8mm.	breadth	2· mm.
Length of abdomen	4·8mm.	breadth	2·8mm.

One specimen of this curious species which is a young male in the next to last moult. Cephalothorax yellow, with white stripe on each side, and extreme margin black; the radiating bands on cephalothorax as usual; the front row of eyes and S. E. of second row on a black band; each upper M. E. surrounded by a black ring; cephalothorax covered with scattered fine black hairs; on the head are five lines of black bristles; two on each side, one arising from the upper S. E. and one from the upper M. E., these run caudad and soon disappear; another arising between the lower M. E. and passing above between the upper M. E. and then runs caudad to the dorsal groove, this is very distinct; mandibles dark yellow-brown; mouth-parts and sternum yellowish, latter darker on edges, both with long black hairs; legs yellowish, with darker rings on femora; legs with long black hairs, sometimes becoming bristles; the arrangement of these is very peculiar. A linear space on under side of coxæ is barren of hairs; two linear spaces on upper side of femora and patellæ are also bare; between them the hairs are long

and bristly; on hinder side of femora another barren stripe; near tip of femora are some short dark lines not of hairs, in one of them is a very large and long spine; the joints beyond show less trace of lines and are densely covered with long black hairs which give the appearance of being very black in color; abdomen whitish with scattered dark spots, very indistinct on venter; head long and narrow and very distinct from the cephalothorax.

One specimen, Summit Marsh, Aug.

Cœlotus gnavus, nov. sp.

Total length	♀		6·9mm.
Length of cephalothorax	3mm.	breadth	2· mm.
Length of abdomen,	4mm.	breadth	2·2mm.

Cephalothorax brownish-yellow with a black marginal seam; mandibles similar; legs same but lighter; sternum darker; abdomen almost wholly covered with black, leaving only numerous small white spots; spinnerets yellow-brown; epigynum reddish; surrounded by black; lung plates white: epigynum with a simple oval opening behind.

This may be what Emerton has called the ♀ of *C. longitarsus*.

One specimen.

Tegenaria derhami Scop.

Frequent in houses.

Cicurina complicata Em.

One specimen, female.

Cicurina arcuata Keys.

Common under leaves in autumn and winter.

Cicurina pallida Keys.

Not uncommon under leaves in winter.

Six Mile Creek, Fall Creek.

Cicurina creber, nov. sp. Plate I, figs. 76, 76a, and 76b.

Total length	♀ and ♂		3·3mm.
Length of cephalothorax	1.4mm.	breadth	1· mm.
Length of abdomen,	1·9mm.	breadth	1·2mm.

Size varies, some larger and some smaller. Cephalothorax pale yellow-brown, scarcely darker on head; eyes surrounded by a little black; mandibles a little darker yellow-brown; legs and palpi light yellow-brown, distal joints brightest; sternum yellowish; mouth-parts darker; venter whitish with faint traces of darker spots; spinnerets white, surrounded at base by blackish; epigynum red and

very prominent; abdomen grayish-white with a more or less distinct medium dark stripe on basal part of dorsum, not reaching to the middle of abdomen; behind this several pairs of dark spots sometimes indistinct or wanting; abdomen covered with white hairs; legs with both white and black hairs and red-brown spines; sternum with black hairs.

Abundant under leaves in autumn and winter.

Cicurina placida, nov. sp. Plate I, fig. 77.

Total length ♀ 5mm.

Very similar to *C. creber;* color and markings the same; sometimes the abdomen has a spot each side of the basal stripe. Differs from *C. creber* chiefly in size and in the shape of the epigynum, which is not as prominent as in that species. Cephalothorax sometimes redder than in that species.

Not uncommon under leaves with the other species. Coy Glen, Buttermilk Creek, Fall Creek.

Hahnia radula Em.

One specimen.

Hahnia bimaculata Em.

Frequent under leaves in winter.

Fall Creek, Cascadilla Creek, Six Mile Creek.

Hahnia cinerea Em.

Uncommon, under leaves as the other species.

Fall Creek, Buttermilk Creek.

Agalena nævia Bosc.

Abundant and extremely variable.

Amaurobinæ.

Dictyna volucripes Keys.

Frequent in grass all summer; often with young.

Dictyna sublata Hentz.
D. muraria Em.

Common in summer on grass.

Dictyna longispina Em.

Not uncommon; summer in grass.

Dictyna minuta Em.

Not uncommon; summer in fields.

Dictyna cruciata Em.?

One specimen, probably this species.

Dictyna foxii Marx.[1] Plate I, figs. 78 and 78a.

Total length ♀ 2mm.

Cephalothorax pale yellow-brown; darkest in front; mandibles similar; eyes surrounded by black; front M. E. very small; legs yellowish, growing brighter from behind forward; sternum a little yellowish; abdomen white, with a short median spot on front of dorsum black, and behind this several black bands, somewhat in the form of chevrons, fainter spots on the sides; spinnerets more or less surrounded by black.

Two specimens, Oct., Fall Creek.

Dictyna volupis Keys.

Abundant in grass in summer, under bark in winter.

Dictyna frondea Em.

One specimen, South Hill.

Dictyna maxima, nov. sp. Plate I, fig. 79. Plate IV, fig. 79a.

Total length ♀ 4·3mm.
Length of cephalothorax 1·5mm.

Abdomen swollen with eggs.

Cephalothorax almost black, shining, only a little space behind eyes lighter and yellowish; mandibles black; palpi and legs white; sternum and lip dark red-brown, maxillæ lighter; abdomen light-grayish, with many small irregular, silvery spots on sides and dorsum; these leave the appearance of net-work of gray; in these spots are many small gray dots; along each upper side several rusty brown spots, the basal ones largest, apical ones smallest, sometimes these are partially connected; venter with a median red-brown stripe; spinnerets reddish; epigynum as in figure.

One specimen.

Dictyna decorata, nov. sp. Plate I, fig. 81. Plate IV, fig. 81.

Total length ♀ 2·5–2·9mm.

Cephalothorax dark red-brown; head and clypeus yellowish-red; mandibles reddish to yellowish-brown; sternum yellow; maxillæ similar; lip darker; legs white to yellowish; abdomen whitish; venter with a few reddish spots, sometimes in form of a central stripe; dorsum on each side with a red-brown or nearly black

[1] This is *Prodalia foxii* Marx. Proc. Ent. Soc. Wash., 1891.

stripe, sometimes partially divided into spots; these stripes connected at apical end by a broad irregular band of same color; sometimes a few small spots in the enclosed space. Prolongations of the markings often extend down on the sides of the abdomen, especially posteriorly; spinnerets light; the abdomen is somewhat longer and narrower than usual; abdomen above with many blackish hairs.

Several specimens. April under bark, and in summer.

Dictyna dubia, nov. sp. Plate I, fig. 82a.

Total length ♀ 2·7mm.

Cephalothorax dark red-brown, head and clypeus yellowish-red; mandibles yellow-brown; legs and palpi whitish; sternum and lip yellow-brown; maxillæ lighter; venter yellowish; dorsum grayish, covered with yellow spots leaving a gray network, little dots of gray in the yellow spots; each side of dorsum an indistinct stripe of rusty brown, most distinct near base; abdomen elliptical, well rounded.

One specimen.

Amaurobius silvestris Em.

Common under stones.

Titanœca americana Em.

Frequent under stones, Fall Creek, Enfield Creek.

Neophanes Marx.

General structure of *Dictyna;* eyes six in two groups, three each side; calamistrum and cribellum present in both sexes; lip triangular; small species.

Neophanes pallidus Marx. Plate III, figs. 86, 86a and 87.

Length ♀ and ♂ 1·1mm.

Cephalothorax yellow-brown, with a few blackish marks; the eyes on two black patches, one each side; mandibles more yellow than cephalothorax; legs yellowish, basal part of hind pair more white; sternum white, a little tinge of yellow; lip more yellow; abdomen nearly white, a little grayish.

Structure very peculiar; eyes six in two groups; calamistrum and cribellum distinct in both sexes; lip long triangular, a tooth each side of base; spinnerets six, separated; tubules only on adjacent surfaces of under pair; palpi and epigynum as figured; one specimen a little smaller with a greenish abdomen does not seem

different. Found under stones or leaves in holes in the ground often an inch from the surface.

Not uncommon in Buttermilk Creek, Fall Creek, Six Mile Creek. Two female specimens agree closely with these typical specimens, except that the sternum is extremely narrow and the lip broad at tip as seen in fig. 87. It may be a new species but the epigynum is the same.

THERIDIDÆ.

Theridinæ.

Theridium tepidariorum Koch.

Abundant, in houses and about buildings; occasionally found on cliffs in gorges.

Theridium rupicola Em.

Not uncommon, under stones, Six Mile Creek, Dec.

Theridium kentuckyense Keys.

One female; similar to the male but a little larger; epigynum as on Plate V, fig. 43.

Theridium differens Em.

Not uncommon in evergreen trees.

Theridium spiralis Hentz.

More common than the preceding; in evergreen trees and elsewhere.

Theridium murarium Em.

Not uncommon, Six Mile Creek; evergreen trees.

Theridium punctis-sparsum Keys.

Uncommon, Fall and Cascadilla Creeks, Dec., Feb.

Theridium frondeum Hentz.

Very common in summer.

Mimetus interfector Hentz.

Infrequent, Fall Creek, Six Mile Creek, Freeville, Aug. Sept.

Mimetus epeiroides Em.

One young specimen probably this species. Buttermilk Creek, Aug.

Ero thoracica Reuss.

One specimen, Inlet Marsh, March.

Steatoda borealis Hentz.

Common often about buildings.

Steatoda marmorata Hentz.

Not uncommon in gorges.

Steatoda guttata Reuss.

Uncommon, Primrose Cliff, Inlet Marsh; Nov., Dec.

Steatoda triangulosa Walck.

Two specimens.

Dipœna nigra Em.
Steatoda nigra Em.

Not uncommon, Fall Creek, Six Mile Creek.

Argyrodes trigonum Hentz.

Not uncommon in *Linyphia* webs in gorges.

Euryopsis funebris Hentz.

One specimen on campus.

Pholcomma hirsuta Em.

Not uncommon, Buttermilk and Fall Creeks; during autumn and winter.

Erigoninæ.

Ceratinella fissiceps Cambr.

Not uncommon in grass in spring and summer.

Ceratinella similis, nov. sp. Plate V, figs. 61, 61a and 61b.

Total length ♀ and ♂ 1·4mm.

Male sometimes a little smaller than female. Cephalothorax orange; eye region black; legs light yellow-brown; mandibles and sternum orange; abdomen whitish, with a slight grayish-yellow tinge; epigynum and spinnerets dark or black; ♂ palpi with tarsus black; hard spot on male dorsum, orange; muscular impressions of female orange and hard, no hard spot on dorsum; hard spot at base of venter, and a little spot in front of spinnerets; head of male elevated and projecting cephala but not humped; head of female normal.

Frequent, Six Mile Creek, South Hill, Sept., Nov., Apr.

Ceratinella minuta Em. Plate II, fig. 60. Plate IV, fig. 60.

Not uncommon, Fall Creek, Aug.

Ceratinella bulbosa Em. Plate V, fig. 59, 59a.

The female is about the same size as the male, it has no hard spot on dorsum; the abdomen in most of my specimens is dark gray, much darker than in *C. fissiceps*.

Not uncommon. Round Marshes, Fall Creek near Varna; upper part of Six Mile Creek; Oct. March, Apr.

Ceratinella pygmea Em. Plate II, fig. 57.

The female is about the same size and color as the male with a hard spot on dorsum.

One male and one female, Fall Creek and Buttermilk Creek, Oct., Nov.

Ceratinella atriceps Cambr.

Rare, Fall Creek, Inlet Marsh. Feb., March.

Ceratinella mœsta, nov. sp. Plate II, fig. 58. Plate V, fig. 58.

Total length	♂		1·5 mm.
Length of cephalothorax	·7mm.	breadth	·55mm.
Length of abdomen	·8mm.	breadth	·6 mm.

Cephalothorax very dark and brown; legs orange, a little brownish towards the tips, sternum red-brown; hard spot on dorsum dark orange; rest of dorsum dark gray; venter still darker; head very high; hard spot on dorsum, not very large, elliptical, distinct; spinnerets dark.

One specimen. South Hill beyond Buttermilk Creek, Nov.

Ceratinella lætabilis Cambr.

Rare, Cascadilla Creek, Fall Creek near Varna, Febr. March.

Ceratinella brunnea Em.

Uncommon, Cascadilla Creek, Fall Creek, Aug., Feb., March.

Ceratinella micropalpis Em.

Rare, Six Mile Creek, Nov.

Ceratinella placida, nov. sp. Plate II, figs. 54, 54a.

Total length	♂		1·25mm.
Length of cephalothorax	·55mm.	breadth	·45mm.
Length of abdomen	·8 mm.	breadth	·7 mm.

Cephalothorax light greenish-brown; legs nearly white; palpi greenish; sternum greenish-gray; spinnerets and a spot in front of them white; hard spots on dorsum indistinct, a little tinge of orange; the basal one yellowish; abdomen dark gray with a greenish tinge; head of male slightly elevated, not humped, but somewhat pro-

jecting anteriorly; dorsal hard spot large, covering nearly all the dorsum. A female from Cascadilla Creek has a darker abdomen, and the hard spot is brighter than in male; sternum is darker on sides; cephalothorax is more yellow as is also the legs; the hard spot has no distinct limits.

Uncommon, Cascadilla Creek, Burdick's Glen; Sept., Feb.

Ceratinella formosa, nov. sp. Plate II, figs. 55 and 55a.

Total length ♀ 1·8mm.

Cephalothorax dark yellow-brown; darkest at cephalic end; legs pale brownish-yellow; sternum dark; abdomen nearly black, except the upper part of the base, which is covered by a hard spot extending only a little way on the dorsum; this is a bright orange-red color; head not elevated; on apex of dorsum a few faint narrow chevrons of white; the four muscular impressions are about over the middle of the abdomen, the hind pair not much farther apart than are the front pair; these are also reddish in color; abdomen widest somewhat behind the middle.

Rare, Fall Creek, Sept.

Ceratinella annulipes, nov. sp. Plate II, figs. 56, 56a and 56b.

Length ♀ 1·8mm.

Cephalothorax dark chestnut brown; sternum dark red-brown; abdomen dark gray, nearly black above; legs red-brown, most of patella and ends of other joints yellowish; no hard spot, ends of muscles form reddish impressions on dorsum; head not elevated; epigynum as figured.

One specimen.

Ceratinopsis interpres Cambr.

Two specimens, Six Mile Creek and Round Marshes, Oct., Apr. They are redder than in the description of Emerton.

Ceratinopsis nigriceps Em.

Frequent, Six Mile Creek, Buttermilk Creek, Cascadilla Creek, Inlet Marsh, Sept., Jan.

Ceratinopsis nigripalpis Em.

One young specimen. Buttermilk Creek, Sept.

Ceratinopsis frontatus, nov. sp. Plate V, fig 63.

Length ♀ 1·5mm.

Cephalothorax dull yellowish-brown; blacker on head, which is somewhat raised; legs a dull orange or brownish-yellow; sternum

blackish; venter whitish; dorsum a little darkened by small black patches; S. E. on tubercles; epigynum red-brown.

One specimen, Fall Creek, March.

Grammonota pictilis Cambr.

Several specimens, Fall Creek, Sept., March.

Grammonota ornata Cambr.

Two specimens, Fall Creek, near Varna, March.

Grammonota venusta, nov. sp. Plate V, fig 64.

Length ♀ 2mm.

Cephalothorax dark yellow-brown, marginal seam black, eyes on black; indistinct dark lines on cephalothorax; mandibles red-brown; sternum nearly black; legs bright brownish-yellow; abdomen nearly black, with a pattern of light markings similar to the other species but smaller; epigynum black; head a little raised; lung-plates yellowish; cephalothorax nearly smooth, abdomen very hairy; head about one-half the length of cephalothorax, which is broad in front and not much wider in middle.

Two specimens, Coy Glen, Feb.

Spiropalpus spiralis Em.

One specimen, Freville, Aug.

Corniculatia directa Cambr.

One specimen, Fall Creek, Oct.

Corniculatia communis Em.

One specimen, South Hill, Apr.

Corniculatia indirecta Cambr.

One specimen, Six Mile Creek, Apr.

Corniculatia pallida Em.

One specimen probably this species. Round Marshes, Oct.

Corniculatia formosa, nov. sp. Plate V, fig. 35.

Length ♀ 2mm.

Cephalothorax bright yellow; eyes on a black patch; no dark seam; mandibles dusky at tip, rest yellowish; sternum lemon-yellow; legs very pale whitish; abdomen gray, with a tinge of pink, many small indistinct darker patches; epigynum dark; legs long and head low.

Two specimens.

Cornicularia placida, nov. sp. Plate V, fig. 36.

Length ♀ 1·9mm.

Somewhat similar in general appearance to what I have called *C. directa;* but the epigynum is quite different, cephalothorax pale chestnut brown, darker on the head; abdomen nearly white; epigynum reddish; legs and sternum brownish-yellow.

One specimen, Fall Creek, Oct.

Lophomma cristata Blk.

One specimen, South Hill, Apr. Probably this species.

Lophocarenum castaneum Em. Plate IV, fig. 3.

Several females which I take to be this species. The cephalothorax is somewhat more yellowish than in the description; the abdomen is large and well rounded.

Fall Creek, March.

Lophocarenum tristis, nov. sp. Plate IV, fig. 1.

Length ♀ 2·3mm.

Cephalothorax dark red-brown; legs brownish-yellow; mandibles dull reddish-brown, sternum and abdomen very dark gray; head a little elevated; abdomen large oval; the middle of hind margin of epigynum is a little raised; sternum quite convex; legs not long.

Three specimens, Inlet Marsh, Apr.; Fall Creek, Oct.

Lophocarenum florens Cambr.

Not uncommon, Round Marshes, Oct.; Burdick's Glen, Sept.

Lophocarenum unimaculatum, nov. sp. Plate IV, fig. 2, 2a.

Total length	♀		2·4mm.
Length of cephalothorax	1·2mm.	breadth	1· mm.
Length of abdomen	1·6mm.	breadth	1·2mm.

Cephalothorax orange above and below; eyes surrounded by black rings; clypeus and mandibles orange; palpi yellow; coxæ yellowish; base of femora reddish often extending beyond the middle; patella tibia and metatarsus dark, nearly black; tarsus lighter; abdomen orange yellow above and below, with a large bluish-black spot in centre of dorsum, spot rounded behind and pointed in front.

A pretty species found in Inlet Marsh among leaves, Oct.; and later in Nov. under bark.

Lophocarenum miniatum, nov. sp. Plate IV, fig. 4.

Length ♀ 3mm.

Cephalothorax bright orange red, darker near eyes; mandibles, palpi, sternum, coxæ and femora of legs orange-red, other joints of legs lighter; abdomen dark gray; in one specimen an oblique light stripe each side; spinnerets yellowish; epigynum reddish; structure as usual in the genus.

Two specimens, Freeville, May.

Lophocarenum venustum, nov. sp. Place IV, fig. 5.

Length ♀ 2·7mm.

Cephalothorax orange brightest on cephalic part; eyes on black; legs lighter and more yellow; mandibles brownish at tips; sternum orange, abdomen gray; muscular impressions on dorsum brownish, the basal pair larger and just about twice as close together as are the other pair; as seen from the side, on the caudal edge of the mandible, about one-third the distance from the base, is a rounded tubercle.

Two specimens, South Hill beyond Buttermilk; Freeville, Nov., Aug.

Lophocarenum montiferum Em.

Several specimens, Six Mile Creek, Apr.

Lophocarenum parvum, nov. sp. Plate IV, figs. 6, 6a and 6b.

Cephalothorax pale yellowish; a line of black around the head; marginal seam blackish; eyes surrounded by black; size 1·5mm.; legs whitish or nearly colorless; mandibles a greenish-white; sternum a yellowish-brown, darker on edges; abdomen dark gray with a little tinge of green; palpal organ reddish; palpi long, especially the femur, tibia swollen at tip and with teeth; head elevated; groove just behind the S. E., hole in this groove; legs moderately long; cephalothorax widest nearly at hind margin, which is concave.

One specimen, Six Mile Creek, Sept.

Lophocarenum exiguum, nov. sp. Plate V, figs. 7, 7a, 7b.

Length ♂ 1·5mm.

Cephalothorax dark yellow-brown, darkest at cephalic end; marginal seam black; legs bright yellow-brown, distal joints paler; mandibles pale; sternum yellow-brown; darker than legs; abdomen nearly black, with rows of large hairs; head greatly elevated;

upper M. E. can not be seen in a front view. The sternum is very broad, and the anterior margin is straight. The groove and hole on head is just above the S. E.

One specimen, Fall Creek, Jan.

Lophocarenum spiniferum Cambr.

One specimen, South Hill, Oct.

Lophocarenum crenatum Em.

Several specimens, Six Mile Creek.

Lophocarenum crenatoideum, nov. sp. Plate IV, figs. 8, 8a and 8b.

Length ♂ 1·5mm.

Cephalothorax brownish-yellow; eyes surrounded by black; a blackish line around head; legs white or nearly colorless; sternum yellowish-brown, quite dark; mouth-parts and mandibles pale yellowish; abdomen shining, dark gray, a little greenish, with long white hairs; palpal organ scarcely colored; cephalothorax with sides crenate; head narrowed at upper M. E., then widened; a few cross ridges on middle of cephalothorax; cephalothorax broadest at about middle; an elongate groove just behind S. E., hole at cephalic end of groove.

One specimen, Six Mile Creek, Sept.

Lophocarenum erigonoides Em. Plate IV, fig. 9.

Several specimens, Six Mile Creek, Sept.; Fall Creek, Feb.

Lophocarenum formosum, nov. sp. Plate IV, fig. 10. Plate V, fig. 10.

Length ♂ 1·2mm. length ♀ 1·4mm.

Cephalothorax bright brownish-yellow; head darker; marginal seam black; legs paler than cephalothorax; sternum red-brown, edges nearly black; abdomen nearly black, lighter on venter of female; a line of pale spots on each side of venter; abdomen long-haired; tibia of male palpus with two black teeth; head of female scarcely elevated, male considerably raised; hole just behind the S. E.; farther caudad near the end of head is a groove.

Several specimens, South Hill, Six Mile Creek, May, Oct.

Lophocarenum arvensis, nov. sp. Plate IV, fig. 11.

Length ♀ 2mm.

Cephalothorax and mandibles dark red-brown; darkest on head, which is but little elevated, not humped; palpi red-brown; legs bright brownish-yellow; sternum red-brown; abdomen nearly

black; cephalothorax widest in middle, tapering a little and rounded behind; head broad.

Two specimens, Fall Creek in field, Feb., May.

Lophocarenum longior, nov. sp. Plate IV, figs. 12 and 12a.

Length ♀ 2mm.

Cephalothorax dull brownish-yellow; darkest on head; eyes on black rings; black seam scarcely apparent; legs and palpi pale, scarcely colored; mandibles brownish-yellow brighter than cephalothorax; sternum brownish-yellow, blackish on edges; epigynum reddish; venter light gray; dorsum darker gray, but still quite light, lightest at base; the abdomen is longer than usual in the genus; mandibles somewhat convex in front.

One specimen, Burdick's Glen, Sept.

Tmeticus unicorn, nov. sp. Plate IV, figs. 13, 13a.

Total length	♂		1·2mm.
Length of cephalothorax	·55mm.	breadth	·5mm.
Length of abdomen	·75mm.	breadth	·5mm.

Cephalothorax and legs yellowish; abdomen gray; palpi yellow, organ reddish and black, sternum and venter dark gray; horn yellow; legs with many black hairs; spinnerets white; head elevated, no holes; from middle of clypeus projects a slender horn, somewhat larger at tip than in middle; tip with some stiff hairs; the tibia of male palpus with a long projection.

One specimen, Six Mile Creek, Nov.

Tmeticus trilobatus Em.

One specimen, Fall Creek, Oct. The palpus is almost the same as the figure in Emerton, but the tibia seems to have more projections at the tip.

Tmeticus obscurus, nov. sp. Plate II, figs. 14, 14a.

Length ♂ 1·7mm.

Cephalothorax and madibles dull brownish-yellow; eyes on black; legs paler; sternum and abdomen dark, latter a little greenish and lighter above than on venter; head higher than in most species of the genus, as is also the abdomen; cephalothorax broad, widest behind the middle, not much narrowed behind; mandibles with a tooth in front; tarsi of palpi gone, tibia enlarged and with several projections.

One specimen, Six Mile Creek.

Tmeticus flaveolus, nov. sp. Plate IV, fig. 15.

Length ♂ 1·2mm.

Cephalothorax bright brownish-yellow, with a black seam; eyes with black rings; legs yellowish, paler than cephalothorax, first pair darkest, fourth pair lightest; sternum blackish-yellow; abdomen pale greenish-gray; cephalothorax low; widest behind the middle; palpal organ reddish; tibia enlarged and with several short projections, not so much as in *T. mœstus;* palpal organ smaller than in that species; a large tooth in front on mandibles; a female, perhaps of this species a little smaller.

One male and one female, South Hill, Oct.; Fall Creek, Feb.

Tmeticus luxuosus, nov. sp. Plate IV, fig. 16.

Length ♂ 2·2mm.

Cephalothorax a uniform orange; no dark edge; mandibles similar but blackish at tips; black around eyes; legs pale yellowish; sternum light orange; abdomen light gray; no tooth on front of mandibles; cephalothorax broad in front, widest at dorsal groove; abdomen narrow; palpal organ small; tibia swollen at tip, with several projections.

One specimen, Fall Creek, Aug.

Tmeticus rusticus, nov. sp. Plate II, fig. 17.

Length ♂ 1·5mm.

Cephalothorax brownish-yellow; legs somewhat orange, except patella which is yellow; sternum blackish-yellow brown; no teeth on front of mandibles; abdomen black; head a little higher than usual; palpal organ large, dark red-brown, very complicated.

One specimen, Buttermilk Creek, March.

Tmeticus pallidus Em.

Two specimens, Six Mile Creek, Dec.

Tmeticus humilis, nov. sp. Plate IV, fig. 18.

Length ♂ 1·6mm.

Cephalothorax yellow-brown, with a black margin; eyes on black; mandibles yellow-brown, no tooth in front; abdomen nearly black; legs yellow brown but paler than cephalothorax, the first pair darkest; sternum black; spinnerets yellowish; cephalothorax widest at dorsal groove, narrower behind.

One specimen, Inlet Marsh, Nov.

Tmeticus mœstus, nov. sp. Plate IV, fig. 19.

Length ♂ 1·5mm.

Cephalothorax, legs and mandibles brownish-yellow; eyes on black; cephalothorax with a few dark marks, one large one just behind head; and a line each side reaching to the hind S. E.; sternum dark gray, abdomen a little lighter than sternum; cephalothorax widest behind the middle; mandibles large, with a tooth in front; legs quite long; palpi a little longer than usual.

Two specimens, Primrose Cliff, Dec.

Tmeticus debilis, nov. sp. Plate IV, fig. 20.

Length ♂ and ♀ 1·9mm.

Cephalothorax brownish-yellow; eyes on black; seam black; legs lighter than cephalothorax; sternum dark brown; venter nearly black; dorsum of abdomen lighter, very hairy; cephalothorax widest much behind the middle; tibia of palpus not much enlarged.

Several specimens, Inlet Marsh, Primrose Cliff, Buttermilk Creek, Dec., March.

Tmeticus palustris, nov. sp. Plate IV, fig. 21.

Length ♂ 1·9mm. Length ♀ 1·9mm.

Cephalothorax yellow; legs similar but lighter; eyes on black; abdomen dark gray; sternum yellow-brown, darkest on edges; epigynum reddish-black; palpal organ reddish; abdomen of male no wider than cephalothorax, in female the abdomen is wider; head of male a little raised; a tooth on front of male mandibles, legs moderately long.

Two specimens from Round Marshes in May, with a web in the throat of the leaves of the Pitcher plant; one specimen, which appears to be the same, from Fall Creek, Oct.

Tmeticus distinctus, nov. sp. Plate IV, fig. 22.

Length ♀ 1·3mm.

Cephalothorax dull yellowish-brown, with faint blackish markings; no black seam; eyes with black rings; sternum dull yellowish brown, blacker on edges, abdomen dark to light gray; legs dull yellowish-brown, a little duller than cephalothorax; epigynum reddish; head low; cephalothorax not tapering much at either end; legs short.

One specimen, in woods west of Varna, March.

Tmeticus maculatus, nov. sp. Plate IV, fig. 23.

Length ♀ 1·8mm.

Cephalothorax and legs brownish-yellow, quite bright; eyes on black rings; mandibles and palpi a little brighter than cephalothorax, a narrow black seam; sternum blackish; epigynum reddish; abdomen gray, darker on venter; dorsum with several pairs of transverse indistinct white spots, most clearly seen when wet; epigynum of two flat lobes; no traces of teeth on front of mandibles.

Two specimens, Coy Glen, Feb.

Tmeticus minutus, nov. sp. Plate II, fig. 24.

Length ♂ 1mm.

Cephalothorax pale yellowish, head darkest; eyes with black rings; margin scarcely darkened; mandibles brighter than cephalothorax; legs pale, with a little brownish and a little tinge of red, sternum yellowish; abdomen greenish-gray with a few paler spots above; palpal organ dark red-brown; spinnerets white; no tooth on front of mandibles; tibia of palpus not enlarged; the front M. E. are much smaller than the others.

One specimen, in woods west of Varna, March.

Tmeticus gnavus, nov. sp. Plate V, fig. 44.

Length ♂ 1·3mm.

Cephalothorax brownish-yellow, a little darker on edge, with a black margin; eyes on black; mandibles yellowish with a large tooth in front; palpi and legs brighter yellow; sternum dark, nearly black; abdomen dark gray almost black; spinnerets light; cephalothorax very low, wide and short; abdomen narrow; tibia of palpus with several projections.

One specimen, Six Mile Creek, Apr.

Erigone longipalpis Em.

One specimen, Inlet Marsh, April.

Linyphinæ.

Linyphia marginata Koch.

Common.

Linyphia communis Hentz.

Not uncommon, Freeville, May.

Linyphia clathrata Sund.

One specimen, Inlet Marsh, Nov.

Linyphia phrygiana Koch.

Common.

L. phrygiana var. **annulipes.**

A little smaller with distinct rings on tibia, while beyond there is scarcely any red marks. There are one or two extra dark marks on the side of the abdomen near the base; the median stripe on the cephalothorax is divided into four parts on the head, one running to each eye.

A few specimens, Fall Creek.

Linyphia mandibulata Em.

Not uncommon in gorges and elsewhere.

Linyphia variabilis, nov. sp. Plate II, fig. 28.

Total length	largest ♀		4· mm.
Length of cephalothorax	1·9mm.	breadth	·9 mm.
Length of abdomen	2·2mm.	breadth	1·35mm.

Cephalothorax reddish-yellow to red, with a black line on margin, mandibles same as cephalothorax; mouth-parts and sternum dark reddish, sternum often jet black; legs light russet yellow to greenish-yellow; venter dark red-brown; a silvery white band around the sides just above the edge of the dark venter; above this a dark red-brown stripe, about same width or wider, this occasionally sub-interrupted at middle. On dorsum within this last stripe, the ground color is chocolate or lighter, with small silvery spots, and when fully developed the ordinary folium like *L. marginata,* but usually more or less broken; spinnerets black. Cephalothorax narrowed just in front of first pair of legs; gradually elevated toward the eyes; deeply emarginate behind; area occupied by M. E. higher than broad, and broader behind than in front; S. E. touching each other; legs hairy, with few spines; specimens not quite adult of both sexes.

Not uncommon, Round Marshes, Fall Creek, Six Mile Creek, Oct., Feb.

Linyphia conferta Hentz. Plate II, fig. 38.

Total length	♀ and ♂ young		3·3mm.
Length of cephalothorax	1·1mm.	breadth	·9mm.
Length of abdomen	2· mm.	breadth	1·1mm.

Cephalothorax yellow-brown; eyes on black; a black seam; mandibles yellow-brown; legs pale greenish, sometimes a little darker at ends of joints; sternum black; venter dark red-brown

extending half way up the side; just above this a line of silvery spots, smaller in size than in *L. variabilis;* above this a row of blackish spots; dorsum reddish or yellowish, with very few small silvery spots; on middle of dorsum a pair of red-brown spots; behind them another pair, sometimes united to a larger darker spot at end of dorsum; base of dorsum with no dark spots; the end of abdomen is more like a *frontina* than is that of *L. variabilis;* the tarsus of the male palpus as far as developed, is much more triangular than that of *L. variabilis.*

Infrequent, South Hill, Apr.; Six Mile Creek, Oct.; Fall Creek, March.

Stemonyphantes bucculentus Clerck.

Infrequent, Buttermilk Creek, Six Mile Creek, Fall Creek, South Hill. During autumn and winter.

Diplostyla nigrina West.

Infrequent, Enfield Creek, Sept., Six Mile Creek, Nov. and Apr.

Diplostyla pallida, nov. sp. Plate II, fig. 29.

Length ♂ 2mm. length ♀ 1·9mm.

Cephalothorax pale greenish; legs similar or paler; sternum more brownish; mandibles more yellow; eyes with a little black, abdomen grayish above, with several darker, but not black, cross bands; sides and venter similar to these cross bands; epigynum nearly white, with a reddish spot each side; palpal organ reddish-brown; legs very long, head of ♂ more elevated than in ♀, and with a few stiff hairs; ♂ mandibles larger than ♀.

Three specimens, Williams Brook, Summit Marsh, Aug.

Diplostyla alboventris, nov. sp. Plate V, fig. 31.

Total length	♀		2·2mm.
Length of cephalothorax	·8mm.	breadth	·6mm.
Length of abdomen	1·6mm.	breadth	·9mm.

Size varies somewhat more than usual.

Cephalothorax yellow-brown, darkest at cephalic end and around edges; eye-region blackish; mandibles, palpi, mouth-parts and sternum similar to cephalothorax; legs lighter with a tinge of green; abdomen white, cream or grayish, with a broad black stripe on each side reaching to the spinnerets; above sometimes with a basal median black spot; behind this four cross-bands, black; the first two sometimes divided in the middle; the fourth often reaches to the stripe on side, the others do not; sometimes a trace of a fifth

cross-band; epigynum is part reddish; legs with a few spines. The male is sometimes a little larger than female; colors similar, except that there is a dark spot at base of venter, which extends caudad in some specimens and may darken the whole venter; palpal organ dark reddish; it is a beautiful structure.

Locally common, exceedingly so on Beebe Island, Fall Creek; also found in Inlet Marsh; autumn and winter.

Diplostyla concolor Reuss.

Not uncommon in Inlet Marsh, Sept., Nov.

Drapetisca socialis Sund.

Two specimens, male and female.

Helophora insignis Blk.

Infrequent. Dryden Lansing Swamp, Sept.; Six Mile Creek, Sept.; Fall Creek, Aug.; Round Marshes, Oct. Varies in size and markings.

Bathyphantes minuta Blk.

Inlet Marsh. One specimen, Nov.

Bathyphantes nebulosa Sund.

In houses. Forest Home and Heustis St., March and Nov.

Bathyphantes zebra Em.

Common in autumn and winter under leaves.

Bathyphantes alpina Em.

Frequent, Inlet Marsh, Buttermilk Creek.

Bathyphantes subalpina Em.

Frequent, Cascadilla Creek, Buttermilk Creek.

Bathyphantes decorata, nov. sp. Plate II, fig. 41.

Length ♀ and ♂ 1·9mm.

Cephalothorax yellow with black around eyes; a black margin; sometimes a dorsal median stripe black; legs with basal joints yellowish, distal joints paler; sternum dark brown to blackish; venter and sides of abdomen in ♂ dark, in ♀ lighter gray; sides with two silvery spots; dorsum pale with no dark markings or indistinct; a middle interrupted dark chevron and two or three, usually more complete, behind this; apex dark, a number of silvery spots in dorsum; epigynum reddish, as is also palpal organ; eyes prominent and projecting, head slightly more raised and projecting in male than female; legs long; abdomen slender.

Infrequent, Burdick's Glen, Sept.

Bathyphantes argenteomaculata, nov. sp.

Largest female, young, 2·3mm.

Cephalothorax pale yellowish, as are also the legs; eyes surrounded by black; margin of cephalothorax dark; sternum dark; abdomen light gray above with many small indistinct brownish spots and larger silvery spots which form two oblique stripes each side that approach each other, and several cross-bands on dorsum; legs very long; abdomen as usual.

Several specimens of this pretty species were found in Six Mile Creek in Sept., all young.

Bathyphantes pallida, nov. sp. Plate V, fig. 42.

Length ♀ 1·25mm.

Cephalothorax light yellow-brown; legs same color, somewhat brighter; palpi a little more gray; sternum gray or dark gray; abdomen gray or nearly white on dorsum shading into dark gray on venter; epigynum red at tip, and considerably projecting as seen in the figure; spinnerets light.

Four specimens, Six Mile Creek, Dec., Apr.; Fall Creek, Oct.

Bathyphantes sabulosa Keys
Linyphia sabulosa Keys.

Uncommon, Six Mile Creek, Oct.

Bathyphantes zygia Keys.
Erigone zygia Keys.

Not uncommon during autumn and winter under stones and leaves.

Bathyphantes formica Em.

Two specimens, Freeville, Aug.

Bathyphantes umbratilis Keys.
Erigone umbratilis Keys.

In field, May. A few specimens.

Bathyphantes complicata Em. Plate IV, fig. 26.

Uncommon, South Hill, Oct.; Fall Creek, March, Oct. The palpal organ agrees pretty closely with Emerton's figure; the color of the cepalothorax and legs is, however, yellowish, not orange.

Bathyphantes unimaculata, nov. sp. Plate II, figs. 65 and 65a.

Length ♂ and ♀ 1·9mm.

Cephalothorax greenish-gray with small blackish irregular patches; eyes on black; legs brownish-yellow; sternum black; abdomen dark gray; darkest on venter, almost black; a pale spot

near apex on dorsum, this is plain in both sexes; the male palpi are not long, the organ compact, the tarsal hook is very large and projects out to one side; epigynum reddish.

Not uncommon, Fall Creek, Six Mile Creek, Feb.

Bathyphantes inornata, nov. sp. Plate V. fig. 66.

Length ♂ and ♀ 1·8mm.

Male a little smaller and narrower.

Cephalothorax and legs yellow-brown, eyes on black; abdomen blackish or grayish, often with a greenish tinge, and with many little whitish dots; sternum dark brown or nearly black; epigynum and palpal organ reddish; head of male not raised; abdomen without markings, or at most with a few narrow light cross-lines on dorsum near apex.

Common under stones in fields, autumn and winter.

Bathyphantes tristis, nov. sp. Plate II, fig. 45.

Length ♀ 1·5mm.

Cephalothorax and legs dull brownish-yellow, blackish near margin of cephalothorax; eyes with black rings; mandibles brighter yellow; sternum blackish; abdomen dark brown or nearly black; epigynum dark red-brown, showing as a roundish projection; legs not very long.

Uncommon; Fall Creek, March; Six Mile Creek, March; Inlet Marsh, Nov.

Micronetа viaria Blk.

Several specimens, Fall Creek, Oct., Nov.

Micronetа latens, nov. sp. Plate V, fig. 46.

Length ♀ 2·1mm.

Young males about the same size.

Cephalothorax brownish-yellow, with a black margin, and dark rays each side; eyes on black rings; legs and palpi yellowish, sometimes with a little tinge of green; mandibles and mouth-parts yellow-brown; sternum dark gray; abdomen very dark almost black, sometimes with a tinge of green; epigynum reddish; spinnerets light; abdomen widest a little behind the middle; cephalothorax low, broadest behind the middle; legs long and slender; epigynum quite similar to *M. quinquedentata.*

Common on wet ground, during autumn and winter.

Micronetа quinquedentata Em.

Common in autumn.

Micronetа palustris, nov. sp. Plate II, fig. 47.

Length ♂ 2·9mm.

Cephalothorax dark orange brown, shining; legs brighter, first pair darkest, tips of legs darker than base; mandibles as cephalothorax; sternum red-brown; abdomen black, hairy; legs with long black hairs; tibia of male palpus small, without teeth, femur long; S. E. touching; upper M. E. larger than lower and a little farther apart.

Two specimens, Negundo woods, Feb.

Micronetа discolor Em.

Several specimens, Fall Creek, Feb.

Micronetа cornupalpis Em.

Not uncommon, Fall and Six Mile Creeks, Nov., March, April. Some females are twice as large as others.

Micronetа luteola, nov. sp. Plate II, fig. 48.

Length ♂ 2·3mm.

Cephalothorax bright brownish-yellow; margin scarcely darker; eyes with black rings; mandibles yellowish; legs lighter than cephalothorax; sternum yellow with dark edges; venter blackish gray, with a pale line each side; dorsum gray, with a whitish band near apex, and in front of this a number of small indistinct light spots; palpal organ dark reddish; legs very long; cephalothorax very broad and low; head broad.

One specimen, Fall Creek, Nov.

Micronetа flaveola, nov. sp. Plate V, fig. 49.

Length ♂ 1·2mm.

Cephalothorax, mandibles, and legs, pale brownish-yellow; eyes with black rings; sternum blackish; abdomen greenish-gray, lighter above, somewhat blackish on venter; palpal organ reddish; palpi short; legs long; tibia of male palpus small; abdomen small and low.

One specimen, Six Mile Creek.

Micronetа complicata, nov. sp. Plate II, fig. 50.

Length ♂ 2·7mm.

Cephalothorax orange yellow; eyes with black rings; mandibles slender and narrow, yellowish; legs yellowish, a little lighter than

cephalothorax; sternum blackish-yellow; abdomen nearly black; spinnerets white; cephalothorax low and broad; male palpi dark reddish, very large; tarsus with a short but prominent spur and below it a curved hook; palpal organ extremely complicated.

One specimen, Michigan Hollow Swamp, Apr.

Micronetа minutissima, nov. sp. Plate II, fig. 27.

Length ♂ ·95mm.

Cephalothorax, mandibles and dorsum of abdomen pale greenish; legs and palpi still paler, almost colorless; palpal organ not much darker; eyes surrounded by black rings, which almost touch each other in the upper row, and do unite in the lower row; abdomen with scattered long black hairs; venter and sternum pale greenish, with a few blackish spots and lines, which make these parts appear darker; legs very long and slender; cephalothorax low, broadest behind the middle, quite broad in front; abdomen low and narrow.

One specimen, Fall Creek, Oct.

Micronetа frontata, nov. sp. Plate V, fig. 51.

Length ♀ 2·4mm.

Cephalothorax reddish-yellow; legs duller and paler; eyes with black rings; sternum yellow, edges more reddish; epigynum reddish, surrounded by yellow; spinnerets yellow; abdomen gray; legs not very long and stout; head broad, abdomen low, and not much longer than cephalothorax, epigynum large and quite peculiar in shape.

One specimen.

Micronetа gigantea, nov. sp. Plate II, fig. 52.

Length ♀ 3mm.

Cephalothorax pale yellowish, blackish on edges, a black central line on head, and one each side of head; eyes, except front M. E., surrounded by reddish rings; front M. E. much smaller than other eyes, and on black; mandibles brighter yellow than cephalothorax; legs pale yellowish, sternum similar; abdomen gray, darker above than on venter; epigynum projecting.

One specimen, Fall Creek, Aug.

Micronetа distincta, nov. sp. Plate II, fig. 53.

Length ♂ 2·9mm.

Cephalothorax and sternum light orange-red; legs and mandibles lighter; eyes on a black patch; abdomen black; clypeus and

mandibles retreating; palpal organ dark, very complicated; tibia swollen and with several projections.

One specimen, Freeville, May.

EPEIRIDÆ.

Epeirinæ.

Epeira corticaria Em.

Locally not uncommon, Dryden Lansing Swamp, Sept.

Epeira silvatica Em.

Rare, Fall Creek, Oct.

Epeira nordmanni Thor.

Common, in gorges, Sept., Nov. Several varieties of the species.

Epeira cinerea Em.

Locally common, on cliffs in gorges, Buttermilk and Fall Creeks, Sept., Nov.

Epeira sclopeteria Clerck.

Common, Aug., Nov.

Epeira patagiata Clerck.

Infrequent, under bark, Inlet Marsh, Nov.

Epeira strix Hentz.

Common, Aug., Nov. and in spring.

Epeira trifolium Hentz.

Common, Sept., Nov.

Epeira marmorea Clerck.

One specimen.

Epeira insularis Hentz.

Common, Aug., Nov.

Epeira thaddeus Hentz.

Not uncommon, Inlet Marsh, South Hill Marsh, Sept., Oct.

Epeira pratensis Hentz.

Not common.

Epeira trivittata Keys.

Common, Sept., Oct.

Epeira domiciliorum Hentz.

Common, Sept., Oct.

Epeira displicata Hentz.

Common, Aug., Oct.

Epeira juniperi Em.

One specimen.

Epeira labyrinthea Hentz.

Common, Sept., Oct.

Epeira globosa Keys.

Rare.

Epeira placida Hentz.

Frequent in wet places, Fall Creek, Round Marshes, June, Sept.

Epeira gibberosa Hentz.

Common in grass, Aug., Sept.

Epeira parvula Keys.

Common, Sept., Oct.

Epeira stellata Hentz.

Infrequent, fields, South Hill, Summit Marsh, Dryden Lansing Swamp, Round Marshes, Aug.

Epeira ithaca McCook MSS.

Not common.

Cyclosa conica Pallas.

Very common.

Singa variabilis Em.

Not uncommon, Round Marshes and wet meadows.

Singa maculata Em.

Infrequent, Buttermilk and Fall Creek.

Acrosoma rugosa Hentz.

One male.

Meta menardi Latr.

Infrequent, Fall Creek, Buttermilk Creek, in dark cliffs, Sept., Oct.

Argiope riparia Hentz.

Common, Sept., Oct.

Argiope transversa.

Not uncommon, Sept., Oct.

Argyroepeira hortorum Hentz.

Not uncommon in grass and herbs, Fall Creek, Six Mile Creek, Sept.

Tetragnatha vermiformis Em.

One specimen.

Tetragnatha extensa Linn.

Not uncommon.

Tetragnatha grallator Hentz.

Very common.

Tetragnatha laboriosa Hentz.

Common.

Tetragnatha straminea Em.

Common.

Tetragnatha caudata Em.

Rare, Inlet Marsh, males and females; the latter resemble the former.

Tetragnatha pallida, nov. sp. Plate V, figs. 88, 88a.

Total length	♂, not including mandibles,		9· mm.
Length of cephalothorax	3· mm.	breadth	1·8mm.
Length of mandibles	3·4mm.	fang	2·8mm.
Length of tibia and patella I	♂		10· mm.

Cephalothorax, legs, palpi, mandibles, mouth-parts and sternum yellowish, lip darker, fang reddish, and tip of palpus a little reddish; abdomen gray with many small silvery spots, no other markings; abdomen long, slender and cylindrical; narrower than cephalothorax; legs long; S. E. farther apart than M. E.; lower S. E. smaller than other eyes; mandibles very long, a large tooth in front; the largest tooth on side is the distal one, fang bent, tibia of palpus about twice as long as patella. It differs from *T. grallator* in position of eyes and shape of mandibles; from *T. vermiformis* in shape of mandibles and length of tibia of male palpus; from *T. straminea* in eyes and mandibles; from *T. extensa* in eyes, mandibles and tibia of male palpus; from *T. laboriosa* in eyes, mandibles and tibia of male palpus; from *T. caudata* in eyes, mandibles and shape of abdomen; from *T. fluviatilis* in position of eyes; from *T. illinoiensis* in position of eyes.

Two male specimens.

Pachygnatha brevis Keys.

Not uncommon in marshes, Nov., Dec.

Pachygnatha autumnalis Keys.

Not uncommon, Fall Creek, Round Marshes, Six Mile Creek, Oct., Dec.

Pachygnatha xanthostoma Keys.

Rare, one specimen.

Uloborinæ.

Uloborus plumipes Lucas.

Rare, Six Mile Creek, Fall Creek, Aug.

Hyptiotes cavatus Hentz.

Very common.

THOMISIDÆ.

Thomisinæ.

Xysticus stomachosus Keys. Plate III, fig. 1.

Several specimens.

Xysticus ferosculus Keys. Plate III, figs. 3 and 3a.

A few specimens, not common.

Xysticus distinctus, nov. sp. Plate III, fig. 89.

Total length	♀		6·7mm.
Length of cephalothorax	3· mm.	breadth	2·9mm.
Length of sternum	1·5mm.	breadth	.9mm.
Length of femur I	3· mm.	tibia I	2· mm.
Length of femur IV	2· mm.	tibia IV	1.6mm.
Distance between epigynum and spinnerets			1·5mm.

Cephalothorax a light reddish-brown on sides, growing darker and containing a large triangular light spot behind, upper edge straight; above a broad light stripe, with a median double line terminated behind by a black triangle; in front each side of this line a little tinged with brown; eyes black; clypeus white; mandibles light; legs pale, above mottled with brownish and a few black spots and with a white line on front pairs, hind legs more distinctly ringed with black at tip of femur, tip of patella, and base and tip of tibia; under side of coxæ with a few brown linear markings; sternum light with a dark border, interrupted in front, the field with many dark dots; mouth-parts brownish, abdomen above light brown, white near the apex; near base a few black spots; near apex a black blotch each side connected by a black line; in front of these two narrow transverse black bands, broadly interrupted in the middle; in front of each black band a narrow light band; venter brown mottled with blackish; epigynum yellow. The M. E. equal and equally far apart, the lower nearer the lower S. E. than to each other; M. E. form a quadrangle broader than high. Two rows of

6-7 spines on under side of tibiæ and metatarsi, I and II. Abdomen broadest behind the middle.

One adult and several young, Indian Spring.

Xysticus brunneus, nov. sp. Plate III, fig. 4.

Total length	♀		8·5mm.
Length of cephalothorax	4· mm.	breadth	4· mm.
Length of sternum	2· mm.	breadth	1·4mm.
Length of femur I	3·2mm.	tibia I	2·9mm.
Length of femur IV	2·5mm.	tibia IV	1·9mm.
Distance between epigynum and spinnerets			2·3mm.

Cephalothorax reddish-brown, darker on cephalic part and on sides; more yellow behind; a brighter narrow stripe on the middle; clypeus same color; falces and palpi reddish-brown; maxillæ, lip, sternum and under side of legs lighter, more yellowish, legs, upper side reddish-brown; distal joints darkest. Abdomen above and below a uniform dark brown, without markings; spinnerets reddish. Cephalothorax widest a little caudad of middle, much higher at middle than in front; clypeus vertical; eyes in two nearly equally-bent rows, those of upper row of about equal size and at equal distances from each other; the four M. E. form a quadrangle wider than high; the lower M. E. scarcely smaller and slightly nearer each other than the upper M. E.; lower M. E. scarcely nearer the much larger S. E. than each other; sternum much longer than wide; abdomen rounded; the epigynum consists of a cavity broader than long at the bottom of which two dark oblong bodies lie separated by a septum. On tibiæ I and II two rows of six to seven spines; on metatarsi I and II two rows of five to six spines.

One specimen.

Xysticus crudelis, nov. sp. Plate III, figs. 5 and 5a.

Total length	♀		8·3mm.
Length of cephalothorax	3·9mm.	breadth	3·8mm.
Length of sternum	2· mm.	breadth	1·5mm.
Length of femur I	3· mm.	tibia I	2·3mm.
Length of femur IV	2·4mm.	tibia IV	1·9mm.
Distance between epigynum and spinnerets			2·7mm.

Cephalothorax yellow, with sides reddish-brown, and above on head same color; the edges of head white; a narrow median consisting of two dark lines; clypeus and eye-region reddish-brown; falces, palpi, mouth-parts, sternum reddish-brown; upper surface of legs yellowish, thickly mottled with dark brown, distal joints darker. Abdomen dark brown, lighter around the anterior sides;

sides of dorsum darkest and separated into three parts by light cross lines; venter dark brown, somewhat reddish in the middle, spinnerets yellowish, reddish-brown at base. Cephalothorax higher in middle than in front; clypeus vertical; the four M. E. form a quadrangle as broad as high; the lower M. E. not smaller, and as far from each other as are the upper M. E. from each other, and nearer to the larger S. E. than to each other; eyes of upper row at about equal distances, and of nearly equal size. On both tibiæ and metatarsi I and II two rows of five to six spines.

Rare.

Xysticus transversus, nov. sp. Plate III, figs. 6, 6a and 6b.

Total length	♀		8· mm.
Length of cephalothorax	3·5mm.	breadth	3·2mm.
Length of sternum	1·7mm.	breadth	1·2mm.
Length of femur I	3· mm.	tibia I	2· mm.
Length of femur IV	2·2mm.	tibia IV	1·6mm.
Distance between epigynum and spinnerets			2·7mm.

Cephalothorax light yellowish, with a dark reddish-brown band each side terminated by two black oblong spots; head reddish-brown, edge white, with a narrow median stripe terminated behind by a black spot; clypeus lighter than sides; base of hills of S. E. white; falces, palpi, mouth-parts, sternum and under side of legs light reddish-brown, spotted or striped with darker brown, legs above light reddish-brown with darker spots; a white stripe on femur, patella and tibia I and II. Abdomen brown above, white on posterior sides, and dark brown on venter; spinnerets white with a dark band at base; the brown of dorsum darker toward the apex, and here separated on each side by a few white cross lines into almost black quadrangles. Cephalothorax much higher in middle than in front, widest in middle; clypeus vertical; eyes in two rows about equally curved; the four M. E. form a quadrangle wider than high; the lower M. E. as far from each other as are the upper M. E. from each other; the lower M. E. farther from each other than from the very much larger S. E.; the eyes of the upper row at about equal distances from each other; the upper M. E. somewhat larger than the lower M. E. and smaller than the upper S. E.; abdomen rounded, widest caudad of middle; on metatarsi I and II two rows of four to five spines, on tibiæ I and II two rows of three to four spines.

Not uncommon, Sept. What I take to be the male is smaller 4mm. long; the markings and color similar but brighter; palpus as figured.

Xysticus lentus, nov. sp. Plate II, fig. 67.

Total length	♂		4·5mm.
Length of femur I	3·8mm.	tibia I	2·2mm.

Cephalothorax as broad as long and shorter than femur I.

Cephalothorax reddish-brown on sides; with a light stripe in middle above, a darker somewhat triangular area in front part of this light stripe terminated behind by a black triangle; a light band connecting the S. E.; clypeus and mandibles reddish-brown; sternum pale, with many small brown dots; coxæ lineated with brown; underside of legs pale, with a narrow brown stripe and numerous brown dots; above with darker blotches; metatarsi and tarsi pale. Abdomen brown above, with small white and dark brown transverse spots on hinder part; edge of abdomen with a white line; venter creased with white and brown. The M. E. equal and form a square; lower M. E. nearer to the larger S. E. than to each other, eyes of the upper row at about equal distances. Two rows of four to six spines on under side of tibiæ and metatarsi I and II. Male palpi with the two horny claws projecting from the center as in *X. triguttatus* and *X. discursans*.

Two males.

Xysticus triguttatus Keys.

Several males; one has one of the upper M. E. only about one-sixth the size of the other.

Xysticus nervosus, nov, sp. Plate III, figs. 8 and 8a. Plate IV, fig. 84.

Total length	♀		7· mm.
Length of cephalothorax	3·2mm.	breadth	3·1mm.
Length of sternum	2· mm.	breadth	1·5mm.
Length of femur I	3·2mm.	tibia I	2·5mm.
Length of femur IV	2·5mm.	tibia IV	1·8mm.
Distance between epigynum and spinnerets			2· mm.

Cephalothorax light yellowish, sides mottled and veined with reddish-brown; a narrow dark-edged stripe on head terminated behind by a reddish point; clypeus reddish-brown, in one case a light stripe between the two rows of eyes; falces yellowish, darker toward the base; mouth-parts, sternum, under side of coxæ, femora and palpi light yellow, palpi darker above, rest of legs yellowish-brown, spotted with brown, and with tibia and metatarsi I and II

darker toward the tip. Abdomen reddish-brown with many faint white spots; sides and venter reddish-brown; spinnerets light yellow. Cephalothorax much higher in middle than in front; widest at middle; clypeus vertical; eyes in two curved rows; the eyes of the upper row at about equal distances, and about equal in size; the M. E. of the lower row, about as close to each other as to the much larger S. E.; the four M. E. make a quadrangle much wider than high; the lower M. E. smaller and slightly closer to each other than the upper M. E.; abdomen rounded; two rows of spines on tibiæ and metatarsi I and II, five to seven spines in each row; epigynum consists of a cavity wider than long, somewhat triangular in outline, divided by a low septum.

Total length	♂		5· mm.
Length of cephalothorax	2·4mm.	breadth	2·4mm.
Length of sternum	1·1mm.	breadth	1· mm.
Length of femur I	3·4mm.	tibia I	3· mm.
Length of femur IV	2·1mm.	tibia IV	1·6mm.

Cephalothorax and appendages as in the ♀; abdomen yellowish-brown, venter lighter; three pairs of elongate reddish-brown spots on caudal part of dorsum; a white band on the cephalic edge of each spot; eyes as in the ♀; abdomen longer in proportion to size than in ♀.

Not uncommon in meadows. Sept.; taken in copulation.

Xysticus formosus, nov. sp. Plate III, fig. 9.

Total length	♀		6·4mm.
Length of cephalothorax	2·8mm.	breadth	2·8mm.
Length of sternum	1·4mm.	breadth	1· mm.
Length of femur I	3· mm.	tibia I	2· mm.
Length of femur IV	2· mm.	tibia IV	1·3mm.
Distance between epigynum and spinnerets			2· mm.

Cephalothorax yellow-brown, darkest on head, with a median light line, sides reddish-brown terminated behind by a darker brown spot; margin nearly white; clypeus yellow-brown; base of lower S. E. whitish; mandibles and palpi reddish-brown; legs yellow and brown, base of femora lighter, tarsus darkest; sternum yellowish, darker on sides; venter whitish, sides obliquely striped with brown, spinnerets reddish, dorsum white, with four pair of large triangular spots brown, somewhat connected with each other forming a median serrated white stripe; basal spots largest; quadrangle of M. E. broader than high; four M. E. equally large; upper S. E. larger than upper M. E. and a little smaller than lower

S. E., which are very much larger than lower M. E.; eyes of upper row at about equal distances, lower row with M. E. closer to S. E. than to each other; four pairs of spines on tibia I; four to five pairs on metatarsus I; three pairs on tibia II; four pairs on metatarsus II.

Rare, two specimens; one from woods west of Varna in March.

Xysticus limbatus Keys.

Two males.

Xysticus quadrilineatus Keys. Plate III, fig. 10.

Infrequent.

Xysticus gulosus Keys. Plate III, figs. 7 and 7a.

Infrequent, Six Mile Creek, Sept.

Xysticus maculatus Keys.

Not uncommon, Sept. This may not be this species; if not it is new.

Oxyptila georgiana Keys. Plate III, fig. 11.

Not uncommon, Inlet Marsh, Oct.

Oxyptila conspurcata Thor. Plate III, fig. 12.

Rare, Fall Creek in woods west of Varna, under leaves in March.

Coriarachne versicolor Keys. Plate III, fig. 13.

Common, under bark in winter.

Misumena rosea Keys. Plate III, figs. 15, 15a.

Several specimens.

Misumena georgiana Keys.

One specimen.

Misumena foliata, nov. sp. Plate III, figs. 17, 17a. Plate II, fig. 37.

Total length	♀		5· mm.
Length of cephalothorax	2· mm.	breadth	2· mm.
Length of sternum	1· mm.	breadth	8· mm.
Length of femur I	2·3mm.	tibia I	1·8mm.
Length of femur IV	1·2mm.	tibia IV	9· mm.
Distance between epigynum and spinnerets			1·8mm.

Cephalothorax white or slightly yellowish, with a light brown band each side not reaching to caudal margin, the cephalic ends connected through the eye-region by a broad reddish band, that frequently covers the whole clypeus; eyes surrounded by white; mouth-parts white with black hairs; sternum white. Abdomen whitish, a red horizontal and two oblique bands each side; the

latter often faint; on front of dorsum a red spot; caudal half of dorsum with two red stripes converging to meet just above the spinnerets; venter and spinnerets light, the latter sometimes with a red spot at base. Markings on dorsum vary in quantity; sometimes the red spot on front of dorsum is connected with the two bands behind; sometimes the red bands are so wide that the dorsum appears red with four white bands. Legs whitish, the metatarsi I and II usually a little darker; tibia I and II frequently with two red bands. Front of cephalothorax as high as in middle; widest in middle; lower row of eyes more curved than upper; upper row of equal size; M. E. slightly nearer each other than to the S. E.; lower row about of the same size and at equal distances; the four M. E. form a quadrangle just as broad as high; abdomen widest a little caudad of middle; sternum heart-shaped, almost as wide in front as in middle; body and legs covered with bristles arising from reddish punctures; two rows of spines on tibiæ I and II, two to four spines in each row; two rows of five to six spines on metatarsi I and II.

Total length	♂		4· mm.
Length of cephalothorax	1·8mm.	breadth	·1·75mm.
Length of sternum	·9mm.	breadth	·75mm.
Length of femur I	2· mm.	tibia I	1·8 mm.
Length of femur IV	1·1mm.	tibia IV	·8 mm.

Markings similar to the ♀, a little brighter; the femur I and II with prominent red spots, patella and tibiæ I and II with red bands.

Common, Sept., Oct..

Misumena vatia Clerck.

Common, May and Sept.

Misumena placida, nov. sp.

Total length	♀ juv.		4·8mm.
Length of cephalothorax	·2mm.	breadth	1·9mm.
Length of sternum	1· mm.	breadth	·75mm.
Length of femur I	2.5mm.	tibia I	1·8mm.
Length of femur IV	1· mm.	tibia IV	·6mm.
Distance between epigynum and spinnerets			1·4mm.

Cephalothorax light yellow, with a band each side of reddish-yellow, reaching from the anterior margin and not quite to the posterior; at end of head a small projection entad from each band; eye-region whitish; clypeus a little reddish; legs a light gray-yellow, distal joints a little redder. Abdomen a gray-white above and below; sternum and mouth-parts white; abdomen with many red-

dish punctures, each supporting a blackish hair. Area occupied by M. E. as long as broad, a little broader behind; eyes of upper row of equal size, and at about equal distances; the lower M. E. equal the upper M. E. and are smaller than the lower S. E., to which they are no nearer than to each other; abdomen pointed behind; two rows of four to five spines on tibia I and II, two rows of six to seven spines on metatarsi I and II.

One young specimen.

Runcinia aleatorius Hentz. Plate III, figs. 18 and 18a.
Thomisus aleatorius Hentz ♂.
Runcinia brendelli Keys.

Two females, one with abdomen white, the other with abdomen yellow. Aug., on the campus.

Tmarsus caudatus Hentz.

Not uncommon in Sept., on trees and fences.

Philodrominæ.

Tibellus oblongus Walck.

Common in sphagnum bogs, May.

Philodromus vulgaris Hentz. Plate III, figs. 23 and 23a.

Common.

Philodromus praelustris Keys. Plate III, fig. 19.

What I take to be this species is not very common; one specimen was taken in a house, Oct.

Philodromus signifer, nov. sp. Plate III, fig. 20.

Total length ♀ juv. 5mm.

Cephalothorax white or yellowish, dark brown each side; clypeus light, a brown band extending through the lower row of eyes and ending in the S. E. of the upper row, here enlarged and extending around the upper M. E.; between the upper M. E. arises a short median brown line, extending a short distance caudad; a little removed from the caudal end each side is a small brown puncture; legs white with brown markings; several small spots on coxæ; a band at middle and end of femora; patella suffused with brown; tibia with a band at each end and some small spots between; metatarsus and tarsus with spots, the latter often dirty white; palpi white with brown spots; mandibles yellowish-white with a few brown marks at base; mouth-parts, sternum and venter white, lip a little darker; spinnerets yellowish white. Abdomen white with a dark

brown stripe around each side, not meeting either in front or behind; above a lighter brown cloud covers nearly the whole dorsum; on the anterior part is left two white stripes, which meet at about the middle of the abdomen; behind this a few white spots; at about the middle of the length of each white stripe is a brown puncture. Cephalothorax widest behind the middle, truncate behind and angles rounded; the clypeus but slightly oblique and rounded; eyes all about equal; all M. E. nearer to S. E. than to each other; the upper M. E. nearly as far apart as the lower S. E.; the two S. E. and one upper M. E. form an equilateral triangle; S. E. on tubercles; sternum truncate in front and behind; extending between hind coxæ; abdomen widest behind the middle; base slightly emarginate; probably next to last moult. Male young; same size but legs longer; same coloration except legs with more brown.

Not uncommon in woods, under bark in winter.

Philodromus gracilis, nov. sp. Plate III, fig. 21.

Total length	♀		6·8mm.
Length of cephalothorax	3· mm.	breadth	3· mm.
Length of sternum	1·9mm.	breadth	1·5mm.
Length of femur I	3·1mm.	tibia I	2·7mm.
Length of femur IV	3·6mm.	tibia IV	2·6mm.
Distance between epigynum and spinnerets			2·3mm.

Cephalothorax yellowish-brown, darker brown on sides; clypeus yellowish; falces yellow; lip brown; maxillæ and palpi yellow; sternum light yellow; femora and coxæ light yellow, spotted with brown; other joints darker, with brown spots; venter light; epigynum darker; dorsum of abdomen brown, with many small white spots, larger toward the base; near caudal end a few short, narrow, curved, light cross-bands, best seen when wet. Cephalothorax not much higher in middle than in front; upper row of eyes nearly straight; lower row curved; the four M. E. make a quadrangle wider behind than high, and wider behind than in front; eyes all of nearly equal size; the upper M. E. nearer to S. E. than to each other; the lower M. E. also nearer S. E. than to each other; clypeus nearly vertical, a little convex; abdomen narrower than cephalothorax; widest a little behind the middle; basal edge straight, as are also the anterior sides; hind angle acute; two rows of three spines each on both tibiæ and metatarsi I and II; epigynum consists of a cavity broader than long, a club-shaped body lies across it.

Two specimens, one from Buttermilk Creek, March.

Philodromus unicolor, nov. sp. Plate III, fig. 22.

Total length	♀		4·2mm.
Length of cephalothorax	1·75mm.	breadth	1·8mm.
Length of sternum	1·1 mm.	breadth	1· mm.
Length of femur I	2·1 mm.	tibia I	1·9mm.
Length of femur IV	2· mm.	tibia IV	1·3mm.
Distance between epigynum and spinnerets			2· mm.

Cephalothorax and abdomen gray above, the former with a few brown stripes; legs light gray above, mottled with brown; falces and lip gray; maxillæ lighter; sternum white; legs whitish on under side; palpi gray above, light beneath, black at tip; venter whitish; spinnerets yellowish; epigynum reddish. Cephalothorax flat; widest near caudal end; clypeus a little oblique; eyes about equal; M. E. of both rows nearer S. E. than to each other; the four M. E. make a quadrangle wider behind than high, and twice as wide behind as in front; abdomen as wide as cephalothorax; hind angle slightly acute; three pairs of spines on under side of both tibiæ and metatarsi I and II.

Rare, Sept., on pavement.

Philodromus ornatus, nov. sp. Plate III, figs. 24 and 24a.

Total length	♀		4·5mm.
Length of cephalothorax	1·5 mm.	breadth	1·6mm.
Length of sternum	·95mm.	breadth	·9mm.
Length of femur I	1·8 mm.	tibia I	1·4mm.
Length of femur IV	1·9 mm.	tibia IV	1·1mm.
Distance between epigynum and spinnerets			1·75mm.

Cephalothorax yellowish-white, sides brown; clypeus and eye-region yellowish-white; upper edge of side stripes straight and parallel to each other, falces greenish-yellow; mouth-parts and sternum white; legs and palpi white, distal joints darker, with scattered dark markings. Abdomen above white; venter dirty white; sides black; at the middle, an angular projection of the black of the side extends into the white above; toward the apex of the white above some faint dark chevrons; under spinnerets yellow, upper ones dark; epigynum dark. Cephalothorax and spines as usual; abdomen one and one half times as wide as cephalothorax; hind angle right angled; eyes about equal in size; all except lower M. E. on prominent white hills; M. E. of both rows nearer S. E. than each other; the four M. E. make a quadrangle wider behind, both than in front and high; sternum sharp pointed behind not prolonged between the hind coxæ.

Two specimens.

Philodromus placidus, nov. sp. Plate III, figs. 25 and 25a.

Total length	♀		3·5mm.
Length of cephalothorax	1·5 mm.	breadth	1·4mm.
Length of sternum	1· mm.	breadth	·9mm.
Length of femur I	1·95mm.	tibia I	1·5mm.
Length of femur IV	1·9 mm.	tibia IV	1·2mm.
Distance between epigynum and spinnerets			1· mm.

Cephalothorax white or dirty white; the sides dark reddish-brown, the inner margin of the dark sides not quite parallel; just behind each upper M. E. a short brownish stripe; clypeus dirty yellowish white; legs white with dark markings; one on upper side of coxæ, one at middle and one at end of femora, a few fainter beyond; mandibles dirty yellow-white; mouth-parts nearly white; sternum white. Abdomen and venter white or dirty white; spinnerets reddish; epigynum red-brown; on each side of the abdomen is a dark brown stripe which do not meet in front, but suddenly narrowing at the middle of their length and growing fainter behind, meet above the spinnerets; on anterior dorsum a light brown spear-shaped mark; at each side of the middle a little brown puncture; on each side of the end a larger oblique impression; behind these some faint light brown curved cross-bands. Cephalothorax widest behind the middle; truncate behind, hind angles rounded; clypeus oblique; upper row of eyes equal in size and M. E. nearer S. E. than to each other; lower M. E. smaller and nearer S. E. than to each other; the upper M. E. nearer the lower S. E. than to any other eyes, and nearly as far apart as are the lower S. E.; the upper S. E. on prominent tubercles; sternum truncate in front; prolonged between the hind coxæ, widened behind and truncate; abdomen emarginate at base, widest slightly behind the middle.

Several specimens.

Philodromus minutus, nov. sp. Plate V, fig. 85.

Total length	♀		3· mm.
Length of cephalothorax	1· mm.	breadth	1· mm.
Length of sternum	·8 mm.	breadth	·6 mm.
Length of femur I	1·05mm.	tibia I	·95mm.
Length of femur IV	1· mm.	tibia IV	·6 mm.
Distance between epigynum and spinnerets			1·1 mm.

Cephalothorax white on yellowish-white, the sides reddish-brown; legs white or yellowish-white with a few scattered dark markings; clypeus yellowish; abdomen dirty white or yellowish; darker or brown on the anterior sides, blackish near the apex on each side;

none of the brown extends over into the white dorsum as in *P. ornatus;* above on dorsum three somewhat broad brown stripes, one mesal ending at the middle of the abdomen; behind this a broader one on each side extending two-thirds of the way to the spinnerets; falces, mouth-parts and sternum yellowish-gray; venter gray or white; spinnerets darker at tips; epigynum reddish-brown, eyes on white hills. Abdomen oval, almost twice as long as wide, not much wider than cephalothorax; eyes equal, about as usual; sternum prolonged between the hind coxæ; anterior angles sharp; sides pointed between the coxæ II and III; a series of black dots around the edge.

Uncommon.

Philodromus minusculus, nov. sp. Plate II, fig. 39.

Total length	♀		2·9mm.

Cephalothorax white; brown on each side; abdomen white above, black around the sides; legs light with faint darker bands toward the tip; sternum broad, extending between the hind coxæ, concave in front; abdomen flat; venter light, falces reddish; mouth-parts a little yellowish; the black along the sides is continuous while in *P. minutus* it is interrupted in the middle. Close to *P. minutus*, but no stripes on dorsum, the white much clearer while in *P. minutus* the white is yellowish.

One specimen.

Philodromus exilis, nov. sp. Plate II, fig. 40.

Total length	♀		3·8mm.
Length of cephalothorax	1·4mm.	breadth	1·4mm.
Length of abdomen	2·4mm.	breadth	1·2mm.
Length of sternum	·8mm.	breadth	·6mm.

Cephalothorax light yellow in middle, sides thickly veined with yellow-brown; clypeus yellowish, mandibles and palpi nearly white; sternum whitish, with little punctures most numerous on the sides, of a lavender color; lung-plates white; epigynum reddish-yellow; spinnerets yellowish; venter whitish with lavender punctures, growing more numerous on the sides and behind; dorsum and upper sides of abdomen white washed with lavender, darkest on the sides and behind; the plan of markings is similar to *P. rufus*, a faint median stripe on front of dorsum; behind this two darker stripes which are indistinctly connected with the side stripe; coxæ yellowish; legs all broken off; the sternum is much narrower than

in *P. rufus* and projects farther behind; eyes similar to *P. rufus* but the S. E. are farther from each other than in that species.

One specimen from Freeville, May.

Philodromus rufus Walck. Plate III, fig. 26.

Common.

Philodromus laticeps Keys.

One specimen, ♂ probably this species.

Philodromus aureolus Clerck.

Three young specimens are probably this species.

LYCOSIDÆ.

Lycosa frondicola Em.

Common among dead leaves in gorges.

Lycosa nidicola Em.

Common among dead leaves in gorges.

Lycosa kochi Keys.

Not uncommon among dead leaves.

Lycosa communis Em.

Frequent under stones, South Hill, Six Mile Creek, McKinney's Twin Glens.

Lycosa nigroventris Em.

Rare, Summit Marsh, Aug.

Lycosa pratensis Em.

Common in fields.

Lycosa similis, nov. sp. Plate II, fig. 30.

Total length	♀		10·8mm.
Length of cephalothorax	4·9mm.	breadth	3·7mm.
Length of abdomen	6· mm.	breadth	3·8mm.
Length of sternum	2· mm.	breadth	1·5mm.
Length of femur I	3·2mm.	tibia I	2·5mm.
Length of femur IV	4·1mm.	tibia IV	3· mm.

Cephalothorax yellow; eyes surrounded by black; a brown stripe each side, and a brown margin; the dorsal light stripe is suddenly narrowed at caudal part of head; the anterior portion contains a short dark stripe each side; mandibles reddish-yellow; mouth-parts and sternum yellow, the latter with a faint darker spot in middle; legs and palpi yellow, no darker markings, finely black haired and black spined; venter grayish-yellow; epigynum reddish, very small;

spinnerets like venter; dorsum dark brownish-yellow; a black spear-shaped outline on front part and some cross lines behind this; some small dark spots on rest of dorsum; eyes as usual.

Occasional in fields near Indian Spring.

Lycosa rufiventris, nov. sp. Plate III, fig. 35.

Total length	♀		12· mm.
Length of cephalothorax	5·2mm.	breadth	3·5mm.
Length of abdomen	7· mm.	breadth	4·4mm.
Length of sternum	2·5mm.	breadth	1·8mm.
Length of femur I	3·1mm.	tibia I	2·4mm.
Length of femur IV	3·9mm.	tibia IV	3· mm.

Small female about 10mm. long.

Cephalothorax red-brown; eye-region blackish; a light median stripe, widest in front and gradually tapering toward the hind margin; a light stripe each side somewhat above the margin, occasionally indistinct; mandibles darker red-brown; mouth-parts red-brown, lighter at tips; sternum red-brown; legs and palpi a little lighter, sometimes with very indistinct darker spots or rings; abdomen above and below red-brown like sternum; epigynum surrounded by jet black hairs; no definite plan of markings, only a few scattered small darker spots on dorsum which are often indistinct; abdomen covered with yellow-brown hairs. First row of eyes not quite as wide as second; dorsal eyes farther from each other than are the second row of eyes, and much closer to them than to each other; the epigynum is much like that of *Trochosa avara*, but the species is much larger and no sign of spots on the venter and scarcely a trace of them on dorsum; it is different from what I have called *T. avara*.

Uncommon, Fall Creek, Jan.

Lycosa humilis, nov. sp. Plate III, fig. 36.

Total length	♀		10·5mm.
Length of cephalothorax	5· mm.	breadth	3·1mm.
Length of abdomen	6· mm.	breadth	3· mm.
Length of sternum	2·5mm.	breadth	1·8mm.
Length of femur I	3·4mm.	tibia I	2·5mm.
Length of femur IV	4·4mm.	tibia IV	4· mm.

Cephalothorax red-brown, darkest on upper sides but not a distinct stripe; eye-region nearly black; mandibles and sternum red-brown; legs light red-brown to yellow-brown, darkest on front pairs, no markings on them; palpi like legs; abdomen brown, no stripe; venter lighter brown; maxillæ scarcely tipped with white;

spinnerets like venter; epigynum reddish; legs black haired and spined; abdomen with long black and white hairs and shorter yellowish ones; sternum with stiff black hairs; epigynum surrounded by white hairs; first row of eyes shorter than second; eyes of second row more than their diameter apart, and not larger than dorsal eyes.

One specimen, Round Marshes, May.

Lycosa avara Keys.

Trochosa avara Keys.

Uncommon, Six Mile Creek, March.

Lycosa ocreata Hentz.

Infrequent, Six Mile Creek, Fall Creek, Sept. and Oct.

Lycosa polita Em.

One specimen.

Lycosa scutulata Hentz.

One specimen.

Lycosa vulpina Em.

Two specimens, Six Mile Creek, in holes.

Lycosa crudelis, nov. sp. Plate III, fig. 37.

Total length	♀		15· mm.
Length of cephalothorax	7·9mm.	breadth	5·6mm.
Length of abdomen	8·1mm.	breadth	5·7mm.
Length of sternum	3·9mm.	breadth	3· mm.
Length of femur I	5·2mm.	tibia I	3·6mm.
Length of femur IV	6· mm.	tibia IV	4·7mm.

Cephalothorax red-brown, darker in eye-region; with three light stripes, the median one arising from between the second row of eyes as a fine line, gradually widening and reaching the hind margin, widest at dorsal groove; the side stripes more than their width above the edge, and scarcely as wide as the dorsal stripe; clypeus dark; mandibles nearly black; mouth-parts black, with tips light; sternum jet black with many black hairs; under side of coxæ blackish with black hairs; femora yellow-brown; hinder ones with darker spots; other joints yellow-brown, hinder ones with darker rings, on front ones the rings are scarcely apparent; legs with many black hairs; palpi yellow-brown, tip of last joint darker; abdomen black, clothed with yellow pubescence; a black spear-shaped mark reaching to the middle of the abdomen; on sides yellow and black hairs tend to form narrow lines; venter dark with

black and yellow hairs, which form four yellow stripes; the two middle ones do not reach beyond the middle of the abdomen, the others do; epigynum reddish, surrounded by black hairs; spinnerets brown; dorsal eyes much farther from each other than are the eyes of the second row from each other.

One specimen.

Lycosa immaculata, nov. sp. Plate V, fig. 38.

Total length	♀		14· mm.
Length of cephalothorax	6· mm.	breadth	4·9mm.
Length of abdomen	8· mm.	breadth	5· mm.
Length of sternum	3· mm.	breadth	2·5mm.
Length of femur I	4·9mm.	tibia I	3·3mm.
Length of femur IV	5· mm.	tibia IV	3·8mm.

Cephalothorax red-brown, with a narrow light stripe arising behind the second row of eyes and reaching the hind margin, slightly wider in the middle; on the sides a broader indistinct light stripe; mandibles red-brown; mouth-parts red-brown, lighter at tips; cephalic half of sternum dark brown, caudal half yellowish; legs yellowish, coxæ with black stripes; femora some brownish, but without bands; no bands on other joints; thickly black haired; abdomen may not be normal, dark gray, brownish toward the apex; when wet, a faint black spear-shaped outline on basal half; venter lighter yellowish; epigynum small and reddish; spinnerets reddish-yellow; palpi reddish-yellow; first row of eyes about as wide as second.

One specimen.

Lycosa exitiosa, nov. sp. Plate I, fig. 39.

Total length	large ♂		17· mm.
Length of cephalothorax	9·5mm.	breadth	7· mm.
Length of abdomen	8·5mm.	breadth	5·4mm.
Length of sternum	4·5mm.	breadth	4· mm.
Length of femur I	8· mm.	tibia I	7· mm.
Length of femur IV	9·3mm.	tibia IV	8· mm.

Small ♂ is but 14·5 mm. long.

Cephalothorax yellow or reddish-yellow, with a dark stripe each side, leaving a narrow dorsal stripe of light, which expands to surround the dorsal groove; the extreme margin also dark; a few small dark spots on the light side stripes; mandibles black with light hair; mouth-parts brownish with black hair; sternum yellow or reddish, with a faint darker central mark, and with black hairs; legs yellow or reddish; the metatarsus and tarsus nearly black; other joints with dark marks and rings, most distinct on the tibia;

under side of coxæ with a large brownish-black spot; tarsus of palpus black, rest of palpus yellowish; abdomen dark brown above, light beneath; venter spotted with many small black dots, sometimes forming a band just behind the lung slits; these small black spots also on dorsum, but not so prominent; also a spear-shaped black outline on front of dorsum; spinnerets brownish-yellow; legs with many black spines.

Several specimens.

Lycosa oblonga, nov. sp. Plate III, fig. 40.

Total length	♀		20· mm.
Length of cephalothorax	9· mm.	breadth	6·8mm.
Length of abdomen	12· mm.	breadth	7·4mm.
Length of sternum	4·6mm.	breadth	3·5mm.
Length of femur I	7· mm.	tibia I	5· mm.
Length of femur IV	7· mm.	tibia IV	5·5mm.

Cephalothorax dark brown, with a narrow light stripe arising between the second row of eyes, passing caudad, widening to surround the dorsal groove, then narrowing and reaching the hind margin. A few light spots on the lower sides but not forming a stripe; mandibles jet black; mouth-parts and sternum black; legs and palpi black, with yellowish markings on the femora, partly rings and partly spots; on the tibia and patella a ring; other joints not distinctly marked. Abdomen dark brown, thickly covered with short golden-yellow pubescence, on the sides and venter leaving many small spots of black hairs; above no markings; the hairs are brightest toward the apex of the abdomen; spinnerets dark brown; region of epigynum with many black hairs; a spot of yellow hairs on each lung-plate; a band of black just caudad of the lung-slits. First row of eyes almost as wide as second; dorsal eyes about as those of second row and farther from each other than the latter; epigynum very small.

One specimen.

Pardosa lapidicina Em.

Common in gorges among shale.

Pardosa pallida Em.

Uncommon, Six Mile Creek, Fall Creek, Sept.

Pardosa annulata, nov. sp. Plate I, fig. 41.

Total length	♀		5· mm.
Length of cephalothorax	2·4mm.	breadth	2· mm.
Length of abdomen	2·6mm.	breadth	1·7mm.

Length of sternum	1·4mm.	breadth	1· mm.
Length of femur I	2· mm.	tibia I	1·4mm.
Length of femur IV	3· mm.	tibia IV	2· mm.

Cephalothorax with a broad reddish-yellow stripe each side, above this a broader dark stripe with irregular edges; extreme margin of cephalothorax somewhat darkened; on dorsum a reddish-yellow stripe, widest in front; constricted at end of head and then tapering caudad; eye-region black; clypeus reddish-yellow; mandibles similar; legs and palpi light reddish-yellow, ringed with black, rings on femora not always complete; sternum yellowish, often with a black stripe extending from the caudal end toward the middle; sometimes a few other black marks; on front of dorsum a triangular reddish-yellow stripe not reaching quite to the middle of the abdomen; rest of dorsum is a brown network, yellow between the meshes; the network looks like cross-lines on the meson but at sides, irregular; venter lighter; base yellowish, beyond brownish; spinnerets yellowish; front margin of epigynum raised and dark colored, the hind part also dark colored, the intermediate part so light as to be hardly distinguishable.

Uncommon.

Pardosa venusta, nov. sp. Plate I, figs. 42, 42a.

Length	♀		5·8mm.
Length of cephalothorax	2·7mm.	breadth	1·9mm.
Length of abdomen	3·1mm.	breadth	1·9mm.

Cephalothorax dark brown, with a few indistinct yellowish spots near the sides, eye-region black; a broad central yellowish stripe, contracted in front of dorsal groove, then enlarging to surround the groove and again contracting behind it, and reaching the hind margin; mandibles yellowish with a brownish spot near base; legs and palpi pale with darker rings; sternum black; venter grayish; spinnerets light; sides and dorsum darker, almost black, with many pale yellowish spots; a median basal stripe pointed behind, not quite reaching the middle of dorsum, yellowish; a spot each side of this at base yellowish; at the hind end of this stripe on each side two yellow spots, the hind pair containing a black dot; behind this two pairs of similar spots, united on meson, each containing a black dot; just above the spinnerets several narrow cross-bands of yellow; each side of the median markings, there are other yellowish spots, some quite large, making the abdomen look like a *Cœlotes;*

epigynum quite small; in what I take to be a young ♂ the abdomen is narrower, but the markings the same.

Several specimens.

Pardosa brunnea Em.

Two specimens.

Pardosa gracilis, nov. sp. Plate I, fig. 43. Plate I, fig. 50.

Total length	♀		8· mm.
Length of cephalothorax	4· mm.	breadth	3· mm.
Length of abdomen	4·4mm.	breadth	2·9mm.
Length of sternum	2· mm.	breadth	1·4mm.
Length of femur I	3.3mm.	tibia I	2·5mm.
Length of femur IV	3·5mm.	tibia IV	3· mm.

Cephalothorax dark red-brown with a median light stripe gradually tapering behind; eye-region blackish; mandibles and sternum red-brown; mouth-parts a little lighter; legs and palpi red-brown, with dark spots and rings more distinct on hind pair; abdomen above and below red-brown, with light brown hair; markings not distinct; a spear-shaped blackish outline on front part of dorsum; behind this a few distinct cross-lines, and some small darker spots each side; epigynum reddish; dorsal eyes almost as close to each other as to the eyes of second row. In what I take to be the ♂ the head is somewhat narrower at the cephalic end; length 7·5 mm.; colors similar to ♀.

Not uncommon.

Pardosa albopatella Em.

Not uncommon, Six Mile Creek.

Pardosa nigropalpis Em.

Several specimens.

Pardosa montana Em.

Two specimens probably this species.

Pardosa mœsta, nov. sp. Plate III, fig. 44.

Total length	♀		5·1mm.
Length of cephalothorax	2·5mm.	breadth	2· mm.
Length of abdomen	2·7mm.	breadth	1·9mm.
Length of sternum	1·4mm.	breadth	1· mm.
Length of femur I	2·1mm.	tibia I	1·5mm.
Length of femur IV	2·9mm.	tibia IV	2·2mm.

Cephalothorax almost uniform reddish-brown, somewhat lighter in the middle, head nearly black; clypeus and mandibles yellowish;

sternum black; legs yellowish, redder toward the tips, no distinct rings, but some faint darker markings on side of femora; palpi yellowish; dorsum of abdomen nearly black, a little reddish tinge; venter reddish-brown with a narrow black line each side, and a broader black stripe in the middle; very slight trace if any of lighter markings on the dorsum; dorsal eyes not as close together as in *P. annulata* or *P. pallida*.

One specimen.

Pardosa obsoleta, nov. sp. Plate III, fig. 45.

Length	♀		5·3mm.
Length of cephalothorax	2·3mm.	breadth	2· mm.
Length of abdomen	3· mm.	breadth	1·9mm.

A larger specimen, apparently the same species is 7 mm. long. Cephalothorax dark brown; eye-region black; with a broad median rufous stripe, much constricted in front of dorsal groove, then enlarging to surround the groove and then becoming smaller; mandibles reddish-yellow; sternum black; legs and palpi yellowish, with darker incomplete rings, these only apparent on the upper surface of the legs; epigynum reddish; venter grayish; sides and dorsum nearly black, with faint, apparently irregular blotches of yellowish; the basal stripe not seen; somewhat similar to *P. montana* but the legs paler and less distinctly ringed; all the markings are indistinct.

Two specimens.

Pirata piratica Clerck.

Uncommon.

Pirata insularis Em.

Not uncommon.

Pirata montana Em.

Uncommon.

Pirata montanoides, nov. sp. Plate I, fig. 46.

Total length	♀		3·7mm.
Length of cephalothorax	1·8 mm.	breadth	1·3mm.
Length of abdomen	1·9 mm.	breadth	1·3mm.
Length of sternum	·82mm.	breadth	·7mm.
Length of femur I	1·4 mm.	tibia I	1· mm.
Length of femur IV	1·7 mm.	tibia IV	1·3mm.

Cephalothorax yellow with a dark stripe each side, somewhat widest behind; eyes surrounded by black; a line each side, reaching

from dorsal groove toward the second row of eyes; mandibles, sternum, mouth-parts, legs and palpi yellow; legs in one specimen with indistinct darker rings; abdomen yellow above and below; epigynum reddish; spinnerets yellow; a small black mark on middle of venter; above on dorsum many irregular black spots which leave a central yellow stripe divided by dark cross-lines; very similar to *P. montana;* cephalothorax a little narrower than in that species; epigynum looks like two reddish spots.

Several specimens.

Pirata agilis, nov. sp. Plate I, fig. 47.

Total length	♀		4·5mm.
Length of cephalothorax	2·2mm.	breadth	1·6mm.
Length of abdomen	2·3mm.	breadth	1·7mm.
Length of sternum	1· mm.	breadth	·8mm.
Length of femur I	1·5mm.	tibia I	1·2mm.
Length of femur IV	2· mm.	tibia IV	1·7mm.

Cephalothorax brown, black around the eyes, a yellowish stripe in middle, widest at cephalic end, gradually tapering to the caudal margin; this encloses two lines which extend each side from the dorsal groove to eyes of the second row; no side stripes; mandibles yellowish; sternum yellow, with a dark margin; legs yellow with no markings, distal joints darker; abdomen brownish above and below; spinnerets yellowish, epigynum blackish; a light yellowish stripe above in middle of dorsum, very faint at base, and behind divided by several blackish cross-lines; legs with fine black hairs and long red-brown spines; epigynum appears as a short transverse dark spot.

Several specimens, Fall Creek, March.

Pirata minuta Em.

One specimen.

Pirata exigua, nov. sp. Plate I, fig. 48.

Total length	♀		3· mm.
Length of cephalothorax	1·4mm.	breadth	·9mm.
Length of abdomen	1·6mm.	breadth	·9mm.
Length of femur I	1· mm.	tibia I	·8mm.
Length of femur IV	1·9mm.	tibia IV	1·4mm.

Cephalothorax yellowish, with a black stripe each side, widest toward the caudal end; the extreme margins of cephalothorax also black; eye-region black; median groove black, from the cephalic end of which arises two stripes diverging toward the dorsal eyes; man-

dibles brownish-yellow; legs and palpi yellowish, some dark marks on femora; patella tipped with dark, and tibia with two rings; sternum yellowish with many small black dots; dorsum of abdomen black with many small yellow spots; venter yellowish, with a few black lines and spots; epigynum reddish; spinnerets greenish; upper ones darker; lobe of epigynum reddish, sides of lobe darker.

One specimen, Enfield Creek, Sept.

Aulonia aurantica Em.

One specimen.

Ocyale undata Hentz.

Common.

Dolomedes tenebrosus Hentz.

Common.

Dolomedes urinator Hentz.

One specimen. Six Mile Creek, Apr.

Dolomedes sexpunctatus Hentz.

Frequent on edge of streams.

Dolomedes scriptus Hentz.

Infrequent, Fall Creek, on edge of stream, Sept.

ATTIDÆ.

Phidippus mystaceus Hentz.

Common; in cases under stones in winter.

Phidippus albomaculatus Keys.

One specimen, female.

Phidippus rauterbergii Peck.

A few immature specimens agree very well with the description Fall Creek.

Phidippus mccookii Peck. Plate IV, fig. 83.

One male 10 mm. long probably this species.

Phidippus tripunctatus Hentz.

Common.

Phidippus cardinalis Hentz.

Infrequent.

Phidippus rufus Hentz.

Common.

Phidippus minutus nov. sp. Plate V., figs. 27 and 27a.

Total length	♀		7·7mm.
Length of cephalothorax	3· mm.	breadth	2·6mm.
Length of abdomen	4·9mm.	breadth	2·9mm.
Leg formula	4–1–2–3.		

Cephalothorax and abdomen black, covered with golden yellow short hair, and scattered long black and white hairs; clypeus whitish yellow; mandibles dark, somewhat greenish iridescent; legs reddish with black rings; palpi yellowish, with whitish-yellow hairs; sternum dark-red brown with light hairs; venter red-brown on sides, with yellowish hairs, a broad central light stripe, limited each side by dark; epigynum and spinnerets reddish; dorsum with a band at base, losing itself on the sides; another oblique band on side; two rows of three spots on caudal part of dorsum, white. Second row of eyes not quite twice as far from dorsal as from lateral eyes; dorsal eyes very prominent; first pair of legs largest; tibia I with three strong black spines at tip; anterior coxæ separated by almost width of labium; sternum less than one and one-half times as long as broad.

One specimen.

Philæus princeps Peck. Plate II, fig. 32.

Three males which may belong to this species.

Philæus militaris Hentz.

Abundant.

Dendryphantes capitatus Hentz.

Abundant.

Dendryphantes elegans Hentz.

One male specimen.

Dendryphantes flavus Peck.

Not uncommon; under stones in cases during the winter.

Dendryphantes flavipedes Peck.

Three females, quite similar to the males; epigynum as on Plate II, fig. 33.

Dendryphantes insignis, nov. sp. Plate V, figs. 28 and 28a.

Total length	♀		4·6mm.
Length of cephalothorax	1·8mm.	breadth	1·3mm.
Length of abdomen	2·9mm.	breadth	1·8mm.
Leg formula	4–1–3–2.		

Cephalothorax red, with white pubescence and long scattered black hairs; eyes on a black band; clypeus with white hairs; falces reddish; palpi light, with white hairs; legs yellowish, with reddish at ends of joints, front legs darker; sternum red-brown. Abdomen whitish-yellow, with white pubescence and long black hairs; four red-brown spots each side on dorsum, more or less connected across the middle by chevrons, the basal ones connected by a curved line; a spot above apex red-brown; spinnerets and median stripe on venter red-brown; sides and rest of venter light; epigynum dark; sides with a faint trace of reddish oblique bands. Sternum broad, truncate in front; anterior coxæ separated by more than width of labium; first legs much the stoutest; first and second pairs of legs as in *D. flavipedes*.

Not uncommon.

Dendryphantes ornatus, nov. sp. Plate IV, fig. 29; Plate V, fig. 29.

Total length	♀		4·9mm.
Length of cephalothorax	1·8mm.	breadth	1·3mm.
Length of abdomen	3·1mm.	breadth	2· mm.
Leg formula	4–1–3–2.		

Cephalothorax reddish; eyes on black band; with short white pubescence and long scattered white and black hairs; clypeus with white hairs; mandibles reddish; sternum dark red-brown; legs and palpi yellowish, the femora of first pair more red-brown; legs distinctly ringed with red-brown, and with white pubescence and longer black hairs. Abdomen whitish-yellow, with short whitish pubescence and long white and a few black hairs; dorsum with red-brown bands more or less connected with an irregular central stripe; basal band horseshoe-shaped; three others behind it more straight; upper side white; lower side with a broad red-brown stripe; venter with a broad median red-brown stripe, constricted just in front of red-brown spinnerets, and then widened to surround them. First legs stoutest, but not so large as in some species; anterior coxæ separated by more than width of labium; sternum oblong; abdomen swollen with eggs.

One specimen.

Dendryphantes exiguus, nov. sp. Plate V, fig. 30.

Total length	♀		4·4mm.
Length of cephalothorax	1·8mm.	breadth	1·3mm.
Length of abdomen	2·7mm.	breadth	1·7mm.
Leg formula	4–1–3–2.		

Cephalothorax reddish, with reddish pubescence which has a faint greenish tinge, more green close to the eyes, on sides whiter; eyes on black spots; long black hairs scattered over surface; long white hairs on clypeus; mandibles reddish; palpi and legs yellowish, with short white hairs and longer black ones; no bands on legs, nor stripes; first pair more brownish, sternum light red with white hairs. Abdomen red-brown, with pubescence like cephalothorax, and scattered long black hairs; a white band at base and anterior sides; two rows of small white spots, those behind elongated obliquely; a dark spot behind each light one; two white spots on each side; venter with white pubescence and long black hairs; spinnerets light; epigynum dark. First legs stoutest; anterior coxæ separated by scarcely width of labium; sternum more contracted in front than in *D. insignis*.

One specimen.

Attus palustris Peck.

Not rare, Inlet Marsh, May; Freeville, Aug.

Icius formosus, nov. sp. Plate V, fig. 31.

Total length	♂		7· mm.
Length of cephalothorax	3· mm.	breadth	2· mm.
Length of abdomen	4·1mm.	breadth	1·5mm.
Leg formula	1–4–3–2.		

Cephalothorax dark red-brown; eye-region black, bordered behind by a white band; some patches of white near eyes, and a narrow stripe just above lower margin; rest of cephalothorax probably covered with yellowish, nearly hyaline short hairs; mandibles dark red-brown; palpi, first legs and sternum similar; other coxæ yellow; femora nearly black; other joints yellowish or reddish; many strong spines on upper side of all femora. Abdomen black, above with a basal white band of hairs, and several white spots along each side; rest probably covered with yellowish, hyaline hairs like cephalothorax; venter gray with white hairs and a central dark stripe. Anterior coxæ not separated by width of labium; posterior coxæ touching; second eyes half way between dorsal and lateral eyes; first legs longest and strongest; eye-region equally wide in front and behind; cephalothorax widest at middle; spinnerets black.

One specimen.

Icius albovittatus Keys.

Several males; not *Wala albovittata* Keys.

Icius palmarum Hentz.

One male; Fall Creek, Aug.

Icius mitratus Hentz.

Not uncommon, in cases on evergreen trees. Fall Creek, Oct.; Six Mile Creek, Sept.

Icius hartii Em. 1892. Plate V, fig. 32.

Icius mœstus, nov. sp. Plate V, fig. 33.

Length	♂		5·1mm.
Length of cephalothorax	2·3mm.	breadth	1·8mm.
Length of abdomen	2·8mm.	breadth	1·5mm.

Cephalothorax reddish; eyes connected by a black stripe; whole cephalothorax probably clothed with white hairs; mandibles and mouth-parts red-brown; sternum nearly black; venter with a broad reddish median stripe, and light each side, clothed with white hairs; all except front coxæ yellow; these are reddish; femur I reddish, nearly black above; rest of leg I reddish, tarsus pale; base of patella pale; basal half of femora II, III and IV yellow like coxæ, rest dark red-brown; patella and tibia a little lighter, metatarsus and tarsus pale, the former with tip red-brown; claw blackish. Abdomen dark reddish above and on sides; badly rubbed; with a short basal whitish band; traces of yellowish spots on dorsum; two pairs near the apex are largest, forming incomplete chevrons; in front of them the spots more median. First leg much the stoutest; head projecting over base of mandibles; mandibles oblique; palpi red-brown; three pairs of large spines near tip of tibia I; and one pair at middle, and one at tip of metatarsus I.

One specimen.

Icius elegans Keys.

One young specimen, probably this species, Burdick's Glen, Sept.

Eris octavus Hentz.

One specimen.

Eris nervosus Peck.

One specimen.

Hasarius hoyi Peck.

One young specimen.

Habrocestum latens, nov. sp. Plate V, fig. 34.

Total length	♀		5· mm.
Length of cephalothorax	2·5mm.	breadth	1·9mm.
Length of abdomen	2·6mm.	breadth	1·8mm.

Cephalothorax yellow brown; eye-region covered with black, indented behind by the yellow-brown, with long black hairs, a few reddish hairs around eyes; clypeus with some long white hairs; legs yellowish, without markings, some black hairs and some shorter colored ones, often red or yellowish; sternum nearly white, with edges dark; mouth-parts, coxæ, and under side of femora nearly white; dorsum of abdomen very densely covered with somewhat long colored hairs, red, golden-yellow, and white, with three oblique elongate spots of black each side; long black hairs scattered over dorsum; venter dark gray with white hairs; epigynum dark; anterior coxæ separated by width of labium; sternum oblong, pointed behind; first leg stoutest.

Not uncommon.

Habrocestum cœcatum Hentz.

Uncommon, males; the spine on the tarsus of the palpus is larger and longer than in Peckham's figure.

Habrocestum peregrinum Peck.

Not uncommon; Fall Creek, Sept.

Habrocestum splendens Peck.

Frequent, Fall Creek, Aug. and Sept., Buttermilk Creek.

Saitis pulex Hentz.

Common.

Astia vittata Hentz.

Abundant.

Astia vittata var. **niger** Peck.

One specimen.

Epiblemum scenicum Clerck.

Common.

Admestina wheelerii Peck.

One female which is probably this species.

Total length	♀		4·3mm.
Length of cephalothorax	1·4mm.	breadth	·9mm.
Length of abdomen	2·9mm.	breadth	1·4mm.

Cephalothorax red-brown, nearly black on head; with white hairs, a few rusty hairs in the band connecting eyes; legs pale yellowish with black marks and rings; mandibles dark brown; abdomen gray with silvery spots, and a broad median dark brown serrated stripe; several small brown spots each side; spinnerets

project beyond the end of abdomen; pale above and brown beneath, a brown stripe on each lower side; venter with a few small brown spots mixed in with the silvery; epigynum brown; sternum brown with white hairs; abdomen with white hairs; cephalothorax low; quadrangle of eyes wider behind; second row of eyes half way between lateral and dorsal eyes; anterior M. E. very large; head overhanging the mandibles; abdomen swollen with eggs; broadest behind the middle; anterior coxæ nearly touching; posterior coxæ touching; sternum widest between coxæ II and III; legs short, first pair stoutest; epigynum as figured on Plate II, fig. 34.

One specimen.

Marptusa familiaris Hentz.

Common.

Marptusa rupicola Hentz. Plate IV, figs. 49 and 49a.

Total length	♀		10·4mm.
Length of cephalothorax	4·5mm.	breadth	3·5mm.
Length of abdomen	6· mm.	breadth	3· mm.

Male about same size, abdomen a little narrower.

Cephalothorax red-brown; eye-region black; hinder sides brownish, and a brownish angular cross-band behind, leaving only a yellow-brown spot on hind margin; mandibles red-brown; first leg yellow-brown, much darker at ends of joints; other legs more yellowish with indistinct darker rings; sternum yellowish; anterior coxæ separated, posterior ones touching; venter gray or yellowish; in female with a faint darker median stripe; epigynum reddish, as is also the region of the male openings; spinnerets light; dorsum and sides dark gray with a light central stripe, the posterior part of which is made up of chevrons, and contains a more or less distinct serrated narrow gray stripe; other light spots and lines are mixed in with the gray on the sides, especially in the ♂; body covered with white hairs; a cluster of stiff black bristles just below and behind the lateral eyes. Cephalothorax broad and low; eye-region a little broader in front than behind, more so in ♂ than in ♀; dorsal eyes look more dorsad than in *M. familiaris*.

Resembles the dry cliffs on which it is found; in Fall Creek and Six Mile Creek; three specimens; the first pair of legs of the ♂ is very stout and long; patella and tibia I measuring 5·5 mm.

Homalattus cyaneus Hentz.

One specimen.

Neon nellii Peck.

Not uncommon under leaves in gorges. In winter often attached to a little case.

Zygoballus bettini Peck.

Several specimens.

Synemosyna formica Hentz.

Two specimens, Six Mile Creek and Fall Creek.

Synageles picata Hentz.

One specimen.

Explanation of Plates.

Plate I.

Fig. 39, *Lycosa exitiosa;* fig. 41, *Pardosa annulata;* fig. 42, *Pardosa venusta;* fig. 43, *Pardosa gracilis;* fig. 46, *Pirata montanoides;* fig. 47, *Pirata agilis;* fig. 48, *Pirata exigua;* fig. 50, *Pardosa gracilis;* fig. 51, *Micaria formicoides;* fig. 52, *Thargalia agilis;* fig. 53, *Thargalia perplexa;* fig. 54, *Thargalia fallax;* fig. 55, *Prosthesima rufula;* fig. 56, *Prosthesima frigida;* fig. 57, *Prosthesima blanda;* fig. 58, *Prosthesima immaculata;* fig. 59, *Gnaphosa humilis;* fig. 60, *Drassus humilis;* fig. 61, *Clubiona obesa;* fig. 62, *Clubiona tibialis;* fig. 63, *Clubiona crassipalpis;* fig. 64, *Clubiona pygmea;* fig. 65, *Clubiona abbotti;* fig. 66, *Clubiona lenta;* fig. 67, *Phrurolithus minutus;* fig. 68, *Agrœca ornata;* fig. 70, *Phrurolithus palustris;* fig. 71, *Cybœus giganteus;* fig. 72, *Cœlotes fidelis;* fig. 74, *Cœlotes altilis;* fig. 76, *Cicurina creber;* fig. 77, *Cicurina placida;* fig. 78, *Dictyna foxii;* fig. 79, *Dictyna maxima;* fig. 81, *Dictyna decorata;* fig. 82, *Dictyna dubia.*

Plate II.

Fig. 14, *Tmeticus obscurus;* fig. 17, *Tmeticus rusticus;* fig. 24, *Tmeticus minutus;* fig. 27, *Microneta minutissima;* fig. 28, *Linyphia variabilis;* fig. 29, *Diplostyla pallida;* fig. 30, *Lycosa similis;* fig. 32, *Philœus princeps;* fig. 33, *Dendryphantes flavipedes;* fig. 34, *Admestina wheeleri;* fig. 37, *Misumena foliata;* fig. 38, *Linyphia conferta;* fig. 39, *Philodromus minusculus;* fig. 40, *Philodromus exilis;* fig. 41, *Bathyphantes decorata:* fig. 45, *Bathyphantes tristis;* fig. 47, *Microneta palustris;* fig. 48, *Microneta luteola;* fig. 50, *Microneta complicata;* fig. 52, *Microneta gigantea;* fig. 53, *Microneta distincta;* fig. 54, *Ceratinella placida;* fig. 55, *Ceratinella formosa;* fig. 56, *Ceratinella annulipes;* fig. 57. *Ceratinella pygmea;* fig. 58, *Ceratinella mœsta:* fig. 60, *Ceratinella minuta;* fig. 65, *Bathyphantes unimaculata:* fig. 67, *Xysticus lentus.*

PLATE III.

Fig. 1, *Xysticus stomachosus*; fig. 3, *Xysticus feroculus*; fig. 4, *Xysticus brunneus*; fig. 5, *Xysticus crudelis*; fig. 6, *Xysticus transversus*; fig. 7, *Xysticus gulosus*; fig. 8, *Xysticus nervosus*; fig. 9, *Xysticus formosus*; fig. 10, *Xysticus quadrilineatus*; fig. 11, *Oxyptila georgiana*; fig. 12, *Oxyptila conspurcata*; fig. 13, *Coriarachne versicolor*; fig. 15, *Misumena rosea*; fig. 17, *Misumena foliata*; fig. 18, *Runcinia aleatorius*; fig. 19, *Philodromus prælustris*; fig. 20, *Philodromus signifer*; fig. 21, *Philodromus gracilis*; fig. 22, *Philodromus unicolor*; fig. 23, *Philodromus vulgaris*; fig. 24, *Philodromus ornatus*; fig. 25, *Philodromus placidus*; fig. 26, *Philodromus rufus*; fig. 35, *Lycosa rufiventris*; fig. 36, *Lycosa humilis*; fig. 37, *Lycosa crudelis*; fig. 40. *Lycosa oblonga*; fig. 44, *Pardosa mœsta*; fig. 45, *Pardosa obsoleta*; fig. 86, *Neophanes pallidus*; fig. 87, *Neophanes pallidus* variety; fig. 89, *Xysticus distinctus*.

PLATE IV.

Fig. 1, *Lophocarenum tristis*; fig. 2, *Lophocarenum unimaculatum*; fig. 3, *Lophocarenum castaneum*; fig. 4, *Lophocarenum miniatum*; fig. 5, *Lophocarenum venustum*; fig. 6, *Lophocarenum parvum*; fig. 9, *Lophocarenum erigonoides*; fig. 8, *Lophocarenum crenatoideum*; fig. 10, *Lophocarenum formosum*; fig. 11, *Lophocarenum arvensis*; fig. 12, *Lophocarenum longior*; fig. 13, *Tmeticus unicorn*; fig. 15, *Tmeticus flaveolus*; fig. 16, *Tmeticus luxuosus*; fig. 18, *Tmeticus humilis*; fig. 19, *Tmeticus mœstus*; fig. 20, *Tmeticus debilis*; fig. 21, *Tmeticus palustris*; fig. 22, *Tmeticus distinctus*; fig. 23, *Tmeticus maculatus*; fig. 26, *Bathyphantes complicata*; fig. 29, *Dendryphantes ornatus*; fig. 49, *Marptusa rupicola*; fig. 60, *Ceratinella minuta*; fig. 69, *Prosthesima minima*; fig. 73, *Cœlotes longitarsus*; fig. 74, *Cœlotes altilis*; fig. 79, *Dictyna maxima*; fig. 81, *Dictyna decorata*; fig. 83, *Phidippus McCookii*; fig. 84, *Xysticus nervosus*.

PLATE V.

Fig. 7, *Lophocarenum exiguum*; fig. 10, *Lophocarenum formosum*; fig. 27, *Phidippus minutus*; fig. 28, *Dendryphantes insignis*; fig. 29, *Dendryphantes ornatus*; fig. 30, *Dendryphantes exiguus*; fig. 31, *Icius formosus*, upper fig.; *Diplostyla alboventris*, lower fig.; fig. 32, *Icius hartii*; fig. 33, *Icius mœstus*; fig. 34, *Habrocestum latens*; fig. 35, *Cornicularia formosa*; fig. 36, *Cornicularia placida*; fig. 38, *Lycosa immaculata*; fig. 42, *Bathyphantes pallida*; fig. 43, *Theridium kentuckyense*; fig. 44. *Tmeticus gnavus*; fig. 46, *Micronetа latens*; fig. 49, *Micronetа flaveola*; fig. 51, *Micronetа frontata*; fig. 58, *Ceratinella mœsta*; fig. 59, *Ceratinella bulbosa*; fig. 61, *Ceratinella similis*; fig. 63, *Ceratinopsis frontatus*; fig. 64, *Grammonota venusta*; fig. 66. *Bathyphantes inornata*; fig. 71, *Cybœus giganteus*; fig. 72, *Cœlotes fidelis*; fig. 85, *Philodromus minutus*; fig. 88, *Tetragnatha pallida*.

REMARKS ON THE QUANTITY, RATE OF CONSUMPTION AND PROBABLE DURATION OF NORTH AMERICAN COAL, AND THE CONSEQUENCE TO AIR-BREATHING ANIMALS OF ITS ENTIRE COMBUSTION.

BY ISAAC J. WISTAR.

The object of this paper is to attempt a calculation of the existing quantity of available coal in North America, the present and prospective rate of its consumption, its probable duration, and some of the physical consequences of its entire combustion. As much labor has been bestowed on the United States Census returns of 1889, being the year reported upon in the Census of 1890; and as under legislation of unprecedented stringency its officials have enjoyed an unusually favorable opportunity of demanding and obtaining a great number of reports from every quarter of the country, the figures and conclusions of that Census have been followed where applicable, though not without grave doubts that its statements respecting the carboniferous area may be optimistic and excessive, and regret for its silence on the equally important subject of thickness and quantity.

The entire carboniferous area of the United States including the post carboniferous beds of Virginia and North Carolina, but excluding the doubtful, much eroded and partly ruined beds of the Rocky Mountain territory, as to which scarcely an estimate is, or could now properly be ventured, is given at 219,080 square miles, being larger than any former estimate. By the carboniferous area is meant, however, not the area of mineable coal or any approximation or reference to it, but the whole of that area over which the rocks of the carboniferous series (excluding the subcarboniferous of geologists), as indicated by their relative position, petrology and fossils, come to and constitute the present surface or are within reach of its mining operations. A large proportion of this area never did contain coal, and another portion has long since lost whatever it once contained, the first in consequence of local failures of the original deposits, and the last because of subsequent foldings and contortions, followed by the erosion and loss of their upper or anticlinal folds. In all parts of the coal fields, areas of original barrenness are extensively interspersed, and in much of the richest coal district of Pennsylvania, the seat of maximum disturbance, and to a less extent, in other portions of the field, minor areas are found

where large portions, sometimes amounting to more than two-thirds of the original beds, have been carried bodily away along with their adjacent protecting rocks, the detritus now resting far out on the sea bottom, or scattered along the ancient channels of drainage long since obsolete and covered deep with foreign material.

Again, much of the coal which has escaped this ruin possesses little or no present or future economic value because of such reasons as the following:

1. Its crushed and impaired condition, due to repeated and excessive flexures, overturnings and fractures.

2. Its detached position in small separate residuary basins caused by erosion and entire loss of the adjacent anticlinals, thus forbidding the permanent application of the large amount of capital required to exhaust such small separate areas.

3. The thinness of many of the beds, which do not, and never can admit of mining by any process of extraction, without removing more rock than coal.

Nothing need be said of mere depth, since the article being one of prime necessity, as it becomes scarcer it will be mined at all depths, the increased cost being compensated by advanced price. In England there is no doubt that if the "South Eastern bed" shall be satisfactorily verified, it will be immediately mined though its most ardent advocates give it a minimum depth of 3000 feet.

Nevertheless it is evident that large deductions must be made from the area of the carboniferous measures as these are known to geologists and adopted in the Census reports, before even an approximate knowledge can be reached of the extent of actual coal beds, adapted, as respects separate area and thickness, to supply remunerative coal at this or any future period. How large such deductions should be, we possess at present insufficient data for computing with accuracy, but from the general observations now possible to make, and from the well known tendency of many property owners to exaggerate the resources and value of their possessions whether in reports to Census officials or miscellaneous observers, we may be sure they must be sufficiently large to effect a very material reduction of the general area of the measures, before arriving at the actual area of mineable coal.

It would therefore seem quite a liberal estimate if such reductions were offset against the following items not included in the Census report, viz:

1. The detached basins of the Rocky Mountain region, chiefly of post carboniferous date, which, though occurring over an extensive territory, are mostly thin, small, widely separated, and often of indifferent quality.

2. The inaccessible and inconsiderable coal of the Arctic and tropical regions.

3. The relatively small beds of Nova Scotia and British Columbia.

After allowing such set off, and accepting the Census statement of the remaining carboniferous area as equivalent to a veritable area of mineable coal, we should have the latter fixed for the entire continent of North America at 219,080 square miles, which most practical geologists will probably only consent to accept with grave doubt, especially as no less authority than Professor Dana calculates the extent of the coal bearing area of the carboniferous measures exposed in the United States at 190,000 square miles, of which only 120,000 have workable beds of coal; and for the whole of North America at 208,000.* It is not desired to intrude here too much individual opinion, but after enjoying considerable opportunity of personal observation of the great coal; fields of the United States, Nova Scotia and British Columbia, I do not myself believe that the entire carboniferous exposures in North America contain 150,000 square miles of actual coal beds, including all qualities and thicknesses. Nevertheless it should be remarked in this connection, that though no out-crops or other of the usual external indications have been found, it is possible—though scarcely probable—that some of the upper beds of the carboniferous series extending westerly from the theatre of its greatest development, may underlie the rocks of later horizon constituting the great western plains. But it is well known that the lower members of the true coal measures thin out and disappear in going west from Pennsylvania, until in the first tier of States west of the Mississippi, only the highest beds in general remain, and if these should continue to decline toward the west in any such proportion as they do east of the great river, they must entirely disappear long before reaching the territory occupied by the cretaceous and later beds of the Rocky Mountain district.

Of this assumed continental area of 219,080 square miles of coal bearing territory, the available data for calculating the average thickness with precision is as yet extremely imperfect. The rocks of

*Manual of Geology, pp. 293.

the coal measures proper, excluding the lower or Millstone grit section (generally known in Pennsylvania simply as "the conglomerate"), have an aggregate thickness "varying from 100 to 1000 feet in the Interior coal areas, to 4000 feet where greatest in Pennsylvania, and over 8000 feet in Nova Scotia.†

The general tendency both of the measures and the interstratified coal seams, is to thin off from N. E. to S. W. across the entire territory of the United States, the lower or largest beds gradually disappearing, until in Texas only the top or latest member of the series is present, showing both at the Gordon and the Strawn mines, a maximum thickness of but twenty-two inches. General sections everywhere show thick beds of conglomerates, sand and sometimes limestones, and slaty shales with comparatively thin seams of coal. An extremely favorable section from Western Pennsylvania, taken from Lesley by the last quoted authority, shows in 810 feet of aggregate thickness, a total thickness of coal amounting to 25 feet in eight seams or beds, of which but two, one of six, the other of eight feet, are workable. While every proportion exists between the thickness of the measures and that of the contained coal, as well as between the coal seams themselves, the above is a fairly illustrative section from the best carboniferous field in the United States except the anthracite, which in the most valuable portions of the field probably averages a greater richness. The coal seams themselves though frequently extending continuously and perfectly identified for miles, vary in thickness from an extreme maximum of thirty feet to nothing, even the largest often thinning out over long distances to a meagre layer of carboniferous slate or dirt. In the Lykens Valley Coal Company's operations, for instance, in the lower or Lykens bed at Short Mountain, an extensive and hitherto reliable seam of ten feet, suddenly "pinched" out to such a trace, and was followed through the rock at heavy cost of time and money for over 6000 feet, before it resumed sufficient thickness for mining. These excessive and sudden eccentricities in thickness and value, though occurring to some extent throughout all the coal fields, abound especially in the anthracite district of Pennsylvania, that being eminently the region of contortions, faults, foldings and disturbances, which in fact accompanied or caused the metamorphism by which coal of ordinary volatility, was refined into anthracite. The general continuity and identity of coal seams, accompanied by frequent changes in thick-

† Ibid. pp. 309.

ness and value, is what might have been antecedently expected as soon as the geological history of coal became certainly known. At the time of the coal deposits neither the Allegheny nor the Rocky Mountains existed. South and west of the Green Mountains of Vermont the continental area was flat and low and being without adequate drainage constituted here a vast swamp, there a succession of small morasses, constantly enduring slow and slight changes of elevation; now for a time and in places sufficiently above water to permit the growth of the redundant flora incident to such conditions, then sufficiently below to destroy vegetable life and cover its remains with deposits of sand of varying thickness, sometimes in fresh, sometimes in sea water. In some places ages elapsed before another emergence made renewed vegetable growth possible, in others subsidences and emergences succeeded each other with comparative rapidity, as now evinced by the respective thickness of the carbonaceous beds and the intervening sandstones, as well as by the succession of fossil species of plants and animals.

Thus the secular succession and separation of the coal seams, and the large proportion of those whose thinness deprives them of economic value is intelligibly explained by the then condition of land and water over this area, and the repeated though slow and slight changes in their relative level, while the destruction of a large part of such seams as were once valuable has been plainly due first to the extensive and violent disturbance of which the condition of the beds themselves supplies ample evidence, and next to more recent erosion on a stupendous scale.

It is unnecessary to dilate upon these elementary and well-known circumstances, because they have been for a long time very completely established and are fully set forth in all standard works on the subject, but so much seemed essential to remind the reader of the causes of the preponderance of thin and worthless seams, of the great irregularity both in thickness and condition of the comparatively few workable ones, the injury and even ruin sustained by many, and finally of the tremendous destruction and loss by erosion.

While there is a large amount of detached information available respecting the number and dimensions of workable seams at various points, there has been no such systematic collation of them as may serve for any precise generalization susceptible of proof, nor is it probable that such will be possible for some years to come. Never-

theless by comparing the best verified of these, with personal observation and the result of individual inquiries, one may venture upon an approximation subject to correction as time goes on and precise information becomes more abundant and available. If the problem were presented to practical American geologists, supposing the valuable coal remaining in all workable seams were distributed in a single bed of uniform thickness extending over the entire area, not of coal, but of the carboniferous measures, assumed at 219,080 square miles, what thickness should be assigned to it?, their reply must, as has been seen, be largely hypothetical. Yet being based on the several sources of information above referred to, it would possess value as the opinion of a large body of close and intelligent observers who have given careful observation and study to the subject as the most interesting of their lives.

It is the belief of the present writer that the majority of such observers would assign a thickness considerably less than six feet. But assuming six feet to be an admissible working estimate, and assuming the received quantity of 800 tons of 2240 lbs. each, (about 42 per cent.), as that which is on the average mineable per level acre per foot of thickness, we should then by a simple arithmetical process get the following, viz: 219,080 square miles equal to 140,211,200 acres, multiplied by 6 feet (of thickness) and by 800, being the available tonnage, per foot of thickness from each acre, would give the tonnage, which is 673,013 millions of tons.

The same Census report states the production (and therefore the consumption) during the year 1889, at 141,229,513 short tons of 2000 lbs. each, which is equivalent to 126,097,779 long tons of 2240 lbs. each, and further states the increase of consumption to have been at the rate of 97.57, or in round numbers 100 per cent. per decade.

This rate of known actual increase applied to the present annual consumption for thirty years, then reduced to fifty per cent. per decade for the next forty years, and further reduced to thirty-three and a third per cent. per decade for another forty-two years, would indicate the entire consumption of every accessible ton at the end of 112 years from the year reported on, or say by A. D. 2001.

Of course the above is a broad generalization of results which will probably be reached about the same time but in a different manner. It is probable the rate of annual increase of consumption would during the first half of the period show a much more rapid

acceleration, owing to the increase of population, to exportation, and to the constant new applications of steam power to old and new purposes, and that during the last half of the period it would decline more irregularly, and upon the whole more quickly, in consequence of the completed exhaustion of the more densely populated coal fields, the increased transportation required to distribute the fuel from the more distant ones, and the consequent growing scarcity and higher prices. But take any reasonable rate of increase we may, based on even a partial continuation of existing facts, and distribute it how we may over the century, and the general result will be about the same, viz: practical exhaustion in little more than three generations.

To such minds as may incline to the acceptance of these conclusions as a fair deduction from facts some of which are known and others derived from cautious and reasonable estimates, but of which only a portion are at present susceptible of proof, it will be at once apparent that certain consequences, both economic and physical, must ensue of the very highest importance to the human race and to all animal life: since the latter, except as regards the domesticated and protected species, tends to increase or decline in inverse proportion to that of man, the universal enemy. The former class of consequences belongs rather to the province of the statesmen and the publicist, though it may be pertinent to refer in passing to the general popular conviction with which such reflections are often brushed aside, i. e. that some new "force" or "power" of Nature is likely to be discovered and harnessed into human service long before the happening of an event that is admitted to be at least a century distant.

But if on examination it be found that there exists no intelligent ground for such expectation, then, however agreeable and consolatory, it must be taken as mere optimism, ready to find ease in any baseless and visionary possibility rather than face a fact which as all see, must sooner or later deprive our race of its most useful and effective asset, and materially change all the conditions of civilization, including its capacity to sustain population.

Now on attempting any such examination almost the first circumstance to be noted is, that as no new or previously unknown "force" has ever yet been discovered, it is very improbable,—if not demonstrably impossible—that any such force can exist in Nature without evidence of its presence. The existence and potentialities

of all known forces of the kind such as steam and electricity, were never concealed and have always been known since the first pot was boiled or the first savage was struck by lightning.

What has been discovered is not those, or any other "forces," if we must continue to call them so, but practical and useful methods of eliminating and applying them to our work; and down to this present time that can only be accomplished by the combustion of fuel, without which we know of no way to produce any of them, on a large and useful scale, and at times and places where they are required.

On the contrary there are certain weighty reasons for believing that there can be no considerable unknown power lying concealed anywhere in Nature. For any such power must be either useful or useless in carrying on Nature's operations. If the latter, it must long since have ceased to exist, for nothing that is useless long survives without human protection. But if useful, then it must be an active and perturbing agent, exerting a useful and necessary function of some kind in Nature's laboratory and workshop. But while we can account for, explain and even predict, all great natural phenomena from the smallest chemical reaction to the most stupendous electrical, astronomical and meteorological events, and can even calculate the movements of our earth and all astronomical bodies, tracing every perturbation or eccentricity to its cause, there is no evidence of the function or action of any mysterious or unknown force, no concealed perturber whose mysterious existence and action disturbs our calculations and frustrates our predictions. Then none exists; and all that is left for us to consider is how to reduce to our service those forces that are known, without the use of fuel or artificial heat. Steam and decomposed water must be banished from the available category, for both are simply results of heat, of which, by terms of the supposition, there would remain no useful supply except as it was obtained by the first brain-developed anthropoids, directly from the sun.

There remains for consideration electricity, which may be obtained in minute quantity from chemical reactions, but its production on a useful scale by such methods, is at present inconceivable, unless by the prior production and handling of such vast masses of expensive material as to rob the result of all economic value.

It is even probable that the effective power obtainable from the gravitation of water, is not so great as is often assigned it, even in the most favorable climates. The area of Pennsylvania is 45,000 square miles, or 28,800,000 acres, and the extremes of precipitation on its eastern and western parts may be averaged at 39 inches, of which at least one-fourth, or ten inches, is lost by evaporation. The entire amount of its rainfall would therefore amount to 31,449,600,000,000 gallons per year, or an average of 86,163,287,671 gallons per day. Hence by the received formula $Q = 62.15\ A\ [\frac{1}{2}\ R—E]$, where Q is the daily supply in gallons, A is the catchment area in acres, R is the average annual rainfall, and E the loss by evaporation, both in inches,* is obtained the collectible quantity in Pennsylvania, viz: 41,526,144,000 gallons per day. Assuming that one-half of that quantity reaches the surface at a useful height above sea level and could be all converted into effective power with an average head of 150 feet, the total available power expressed in horse powers would be 524,320 HP per day, being equal to the power obtained by the combustion per year of 3,075,698 tons of coal of 2240 lbs. each, which is probably less than one-tenth of the tonnage actually required and consumed in Pennsylvania to-day.

There are, however, certain conceivable physical results that may and to some extent must follow the combustion and dispersion in the atmosphere of all the carbon now fixed in a form available for fuel, which, though perhaps not at present fully computable, are of the very highest consequence. It may be safely assumed that such carbon, as well as that which is fixed in the calcareous or other carbonates, was for the most part so fixed long after the earth had condensed to its present form and dimensions and had cooled sufficiently to acquire a stable crust. Before that time the greater part or all of such carbon had existed in atmospheric suspension and whenever these compounds shall be resolved it must return to and remain in the atmosphere, until again fixed by the slow and gradual medium of chemical reaction in one case and the operations of vegetable life in the other. Since, however, our present concern is with the coal, the end of which, however more or less remote, we can with certainty foresee, let us endeavor to calculate, though with much necessary recourse to hypothesis, whether any appreciable effect on the atmosphere and on animal life is likely to

* Theory and Practice of Hydro-Mechanics, Inst. C. E. p. 44, cited in Ency. Brit., article "Water Supply."

follow the return to the atmosphere of the carbonaceous constituents of all accessible coal now and for ages past safely contained in the storehouse of the earth. The composition and weight of the existing atmosphere as well as of coal being well known, the first step necessary for such a calculation is to get a world-wide estimate of the quantity of such accessible coal.

Sir Charles Lyell and the early geologists at first supposed that the enormous geological destructions and reconstructions of which they observed the evidences everywhere on the land surfaces of the globe, had equally affected all surfaces, involving the subsidence of continents and the corresponding elevation of sea bottoms, in short a wide and perhaps universal and repeated interchange of continental and oceanic areas. But it has now long been known and in fact proved by the researches of the Challenger expedition and other investigations, that those early views were erroneous, and that notwithstanding the repeated changes of height and level everywhere and at all times prevailing over and throughout all land surfaces, the existing proportions between land and ocean areas have in the main always been maintained at least outside the depth line of 1000 fathoms. The evidence of this important fact is abundant and conclusive, but as it has recently been lucidly summed up in the latest work of Mr. A. R. Wallace,* it need not be repeated here.

Accepting these better modern views, it is clear that under the main portions of the ocean, neither derivative rocks nor fossil vegetation are to be looked for, and cannot exist in appreciable quantity. But the area of the entire land surface of the earth with its included waters, bears to the entire oceanic area the proportion of 28 to 72, according to the careful computations of Mr. John Murray, cited and approved by Wallace, a proportion which, as shown by Mr. Wallace's map of the 1000 fathom line, would not be materially modified if the littoral portion of the sea bottom lying inside that line should be tranferred from the oceanic to the land area.

Now since, as before observed, we possess accurate knowledge both of the constituency of the atmosphere as now existing, and also its weight both as a whole and per square foot of the earth's surface, we only require to know the quantity of coal existing on 28 per cent. of the earth's surface to compute the quantity of carbon

* Darwinism, pp. 341–349.

originally taken by it chiefly from the atmosphere, and conversely, the quantity that will be returned to the atmosphere on the combustion of such coal, making a reasonable allowance in the last case for such portion of the coal as is inaccessible to man and can therefore never be consumed through his agency.

The following computations bearing on this point and graduated to meet several different estimates of quantity, have been made with the assistance of Mr. B. C. Tilghman, an accomplished young chemist of experience and capacity and a member of this Academy.

The oxygen of the atmosphere, 23 per cent. by weight (or about 21 per cent by volume), if all burned into carbonic acid would produce 682·56 lbs. per square foot of earth surface. This would correspond to a weight of 185·76 lbs. of carbon in suspension per square foot of earth surface, and at a specific gravity of 95 lbs. per cubic foot (the average for anthracite) would correspond to a stratum of carbon 23·45 inches thick over the entire earth surface or to 83·71 inches thick on the land surface, assumed at 28 per cent. of the whole. With the aid of Mr. Tilghman the following tabular statement has been constructed from these data, which are repeated in its first horizontal line.

I	II	III	IV	V	VI
Percentage of atmospheric oxygen consumed.	Weight of carbonic acid produced per square foot of all earth surface.	Weight of carbon consumed per square foot of all earth surface.	Percentage of present weight of atmosphere corresponding to the weight of carbonic acid in column II.	Thickness of stratum of carbon required over entire earth surface.	Thickness of stratum of carbon required over land surface only.
	Pounds CO_2	Pounds C.		Inches.	Inches.
100	682·56	185·76	31·60	23·45	83·71
2	13·650	3·714	·632	·4690	1·6742
1	6·825	1·857	·316	·2345	·8371

The first horizontal line of the table represents, merely as a basis, the theoretical results of a total absorption of all free oxygen by carbonization, for which, however, all the available accumulations of carbon that we know of are of course inadequate; for the return to the atmosphere of the carbonic acid formerly subtracted

from it and now fixed in such carbonates as limestones, marbles, chalks and corals, cannot be looked for without the recurrence of such intense heat as there is no longer reason to expect, while on the contrary, the secular diminution of both solar and internal heat must tend to increase rather than diminish the stability of those compounds.

But the lower horizontal lines of the table, or some condition intermediate between them, approximate so nearly to the actual quantity of existing and available carbon accumulations assumed in column VI, that on the entire combustion of such accumulations nothing less can be looked for than the atmospheric modifications indicated in the preceding columns. The last line for instance, shows that assuming all the mineable coal of the earth to equal one stratum of ·8371 of one inch uniform thickness covering the entire land surface (this being taken at 28 per cent. of the whole) its combustion would abstract one per cent. from the existing twenty-three per cent. of all atmospheric oxygen and add ·316 of one per cent. of its present weight to the atmosphere in carbon dioxide.

We are not without means of verifying to some extent this assumed thickness of the supposed universal stratum of carbon. In North America we have seen that the total computed quantity available is 673,013 million tons, a quantity which, if equally diffused over the North American continental area of 7,400,000 square miles, would give a uniform thickness of ·924 of one inch. Since the conditions of the carboniferous period have at one time or other been common throughout all parts of the land surface of the globe as proved by the universal diffusion under similar conditions of coal or fossil vegetation, it would not seem a violent assumption to suppose that when we shall be as well acquainted with the other parts of the world as we now are with North America, it will be found that coal is not on the whole very unequally distributed, and that the tolerably well ascertained fact of the equivalent stratum for North America approximating an inch in thickness, will not be found materially different in other parts of the earth's land e, and may at least be taken at ·8371 of an inch as indi l lowest line of the tabular statement, with all the other fi in the same line as appurtenant.

But just as the original abstraction of carbonic acid f by the carboniferous vegetation has certainly once d extent or other all then existing life and render

evolution of higher forms, so the converse process, though to a less extent—since all coal is not accessible to the destructive power of man—must tend to restore the atmosphere to its precarboniferous condition and to some extent, however minute, impair or restrict its capacity for sustaining the higher forms of animal life as now constituted.

The data and proportions supplied in the table may of course be applied to such assumption of absolute quantities as may best satisfy individual minds. But its proportions are correct, and on any supposition it furnishes proof that some amount of deleterious influence must be exerted on the atmosphere, and therefore on the physical constitution and qualities of all air breathing animals and especially on the higher forms, which, being most specialized, are the least adaptable.

If it be objected that it is not to be accepted without specific proof that all of this carbon dioxide was at any one time in atmospheric suspension, then we have to suppose some agency of constant and steady supply during the enormous vegetable demand of the prolonged carboniferous period. This agency could only have been a vast and long continued amount of internal heat either diffused by steam, or occurring sufficiently near the surface to permit egress. Such heat would have been necessary to expel it from the carbonates in which it had been previously fixed, and must have been at the same time sufficiently intense to fuse and decompose limestone, and yet of a character consistent with the most profuse vegetable growth that has at any period occurred on the earth.

Nevertheless the suggestion is not beyond the bounds of possibility. Large quantities of carbon dioxide have always been, and now are being constantly emitted from the deep recesses of the earth's mass and constitute an essential part of the existing conditions of respiration; and it may be conceded that such dissolution of carbonates and evolution of carbon dioxide may have prevailed to a greater extent than at present before the earth's crust had cooled *at all points* to present temperatures, and may have aided the supply furnished from the atmosphere. But that the process was sufficient of itself to account for the great quantities that were fixed in the coal beds during the carboniferous period is not credible, because not supported either by the comparative absence of such process before and after that period, or by such amount of evidence as

in that case should have left its traces everywhere among all accessible metamorphosed rocks.

It has been suggested that such future accession of carbonic acid to the atmosphere diffused over a century or more, may be met and counteracted by the consequent increased activity of tropical and other vegetation. There is no doubt that as long as the earth continues otherwise fitted to sustain life, we may confidently expect that in the future as in the past, new creatures will be evolved to meet new physical conditions. But there is reason to believe that vegetation, composed as it is of all existing individuals, has fully adapted itself to present conditions including the actual quantity of carbon dioxide heretofore and now being supplied from its own dissolution and decay, and from such sources of natural supply as the breath of animals, forest, prairie and accidental fires, volcanic combustion, subterranean decomposition and others of the kind. The amount of heat and moisture, the principal conditions of vegetable life, is more likely to decline with the slow diminution of solar vigor than to increase, and there is no reason for supposing that the present rate of vegetable growth is in any degree limited or restricted by the want of carbonic acid. If then the quantity, already sufficient, continues to be daily augmented by the ever increasing artificial combustion of coal, its entire absorption by vegetation would require a new and distinct modification in vegetable life. But any such adaptation must proceed in accordance with fixed laws, which never halt or vary to save individuals or species. On the contrary, their inexorable march even toward higher forms involves the remorseless extinction not only of individuals but of whole species, genera and orders, an evolutionary process which would doubtless have kept even pace with the slow *natural* changes of environment, but hardly with the active interference of human intelligence possessing designs of its own in no manner subordinated to the slow and gradual processes of natural development.

Similar considerations apply to the probable effect on animal life of any considerable relative displacement of oxygen from the atmosphere. We know that any—even the smallest—relative increase of carbonic acid is injurious to the life-sustaining quality of air, not necessarily on account of any actively poisonous qualities of its own, but by its displacement or dilution of oxygen, and that an atmosphere containing but eighteen per cent. by weight of

oxygen, is incapable of supporting combustion and closely assails the limits of mammalian life.

If an animal possessing a given extent of lung surface and passages must, as now constituted, transmit through those passages 100 lbs. of air to obtain the necessary 23 lbs. of oxygen, then if some appreciable quantity, say for example, one per cent. by weight of CO_2 be added to the atmosphere, the animal must pass through its organs 101 lbs. of air to obtain the same reparatory result, and so on, in similar proportion, and this result will be accelerated if such addition of carbon dioxide be accompanied by the positive abstraction of oxygen as in the case of the combustion of fixed carbon. But under the continuing effects of diminishing oxygen and increasing carbon dioxide, there must come a time when the growing atmospheric modification can no longer be met by adaptation of individuals, but only by a permanent increase of the rapidity of respiration, or an established enlargement of the respiratory organs; and an animal materially and permanently changed in either respect would amount to a new form, adapted to the new conditions but unable to exist in the old, and only producible by the extinction of existing species no longer fit, and the evolution of favorable variations into new species.

Hence if it seems probable that existing types of vegetation could only absorb materially increased quantities of carbon by developing specific and generic changes, we may with still more confidence conclude that animals adapted to prevailing atmospheric conditions, can only acquire the necessary modifications of their respiratory and associated organs by means equally radical. As the principal air-breathing forms, including most reptiles and all birds and mammals, slowly succeeded the atmospheric changes of the carbon-fixing period, so under the influence of converse modifications it seems justly inferable that they being the most specialized and least adaptable as individuals, must in turn give place to specific substitutions.

Of course the extent of modification in cellular surface or rapidity of respiration to which existing forms can adapt themselves without such specific destruction and substitution, must chiefly be learned from actual experiments by competent hygienists.

But whatever may be the value of such speculations upon ultimate consequences, it is certain that with the large and constantly accelerating increase in the annual rate of production and

consumption of coal, and the growth of population stimulated by its use, it must soon be carefully sought for in every accessible quarter of the world ; and it cannot be many years before such information will be possessed as may enable us to dispense with most of the hypotheses now required, and bring the entire subject of its quantity and duration more or less within the limits of exact computation.

The present object of this paper scarcely aims at more than the hastening of such researches, and quickening the interest of more competent analysts and naturalists.

THE BIRDS OF SOUTHEASTERN TEXAS AND SOUTHERN ARIZONA OBSERVED DURING MAY, JUNE AND JULY, 1891.

BY SAMUEL N. RHOADS.

With the idea of investigating the avifauna of the southern border of the United States, and collecting a series of the birds of Florida, Texas and Arizona,[1] I left Philadelphia March 26th, 1891, arriving at Jacksonville, Florida, on the fifth of the following month. A sojourn of five weeks was made in the southwestern part of the state and considerable collections obtained. Few facts additional to what has been already written on the bird life of this region were ascertained, and it is not my intention to treat in detail of this part of the trip.

I arrived at Corpus Christi, Texas, May 17th, and here a three weeks' stay was made. I then journeyed westward to Tucson, Arizona, arriving on the tenth of June, and collecting birds in the immediate vicinity until the nineteenth. That morning I took stage for Oracle, a post-hamlet situated in the oak belt forty miles northward, among the foot-hills of the Catalina Mountains. Collecting was carried on in that vicinity until July 2nd, when the mountains were ascended, and I took up my abode for a week in a lumber camp among the pines of Mt. Lemon at an elevation of between 7000 and 8000 ft. and about 2000 feet below the summit of that mountain.

The birds of southern Texas, especially those in the vicinity of Corpus Christi, have received no small amount of attention from naturalists. Mr. Beckham enumerates eight publications bearing directly on this subject, prior to his own, which appeared in 1887.[2] Within a few months Mr. Chapman has published a paper[3] giving the results of his observations made on exactly the same ground which I covered three weeks later. In fact, I was conducted by Mr. Priour, who acted as my guide, to the same collecting grounds in the immediate vicinity of Corpus Christi and along the Nueces River and

[1] Mr. Rhoads has generously presented his entire collection, numbering about one thousand skins to the Academy of Natural Sciences of Philadelphia. The Texas series numbers 267 specimens and the Arizona collection 398. Owing to Mr. Rhoads' absence from Philadelphia when preparing this paper, he was unable to make a critical examination of the specimens, and at his request I have added notes on such as exhibited any peculiarities; these annotations are followed by my initials.—Witmer Stone.

[2] Proc. U. S. Nat. Mus. Vol. 10, p. 633.

[3] Bull. Am. Mus. Nat. Hist. Vol. III, No. 2.

Bay, which he had previously visited with Mr. Chapman. The interval between our visits, however, gave opportunity for a decided readjustment of the bird fauna, due to migration and the nesting of resident species.

Mr. Beckham's personal observations of Texan birds terminated in March, and so far as I can discover, very few, if any, of our observers have recorded data relating to the early summer birds of the Corpus Christi region; Dresser's "summer" notes relating chiefly to the vicinity of San Antonio.

Further description of the region included in the following notes would be superfluous after all that the aforementioned authors have written on the subject. Before proceeding with the annotated list, however, the following observations may be made.

Though nearly all the non-resident birds had passed through, and a drouth existed, quite equal in severity to that prevailing during Mr. Beckman's stay, my experience agrees with that of Mr. Chapman—birds were abundant everywhere. Nearly half of the birds observed were feeding their young before my departure, and in many cases the full-fledged young were procured. This rendered all the more conspicuous the fact that many boreal species, especially among the water birds, still lingered. I received corroboration in various ways that the annual over-stepping of faunal limits by many species belonging to a more southerly district, and their subsequent disappearance toward the end of the spring migration, is a marked feature at Corpus Christi. These birds undoubtedly return in due time to their ancestral haunts in Mexico ere the breeding season begins. To what extent this movement, due undoubtedly to the sexual excitability and ignorance of the country exhibited by birds of the first year, should be held to account for the "faunal inosculation" which Beckham speaks of, I am unable to prove. From all that may be proven by and inferred from the observations of collectors in this region ten years ago, it seems that several species are now represented in the avifauna of Corpus Christi which were then strangers to it.

Owing to the position of this territory, forming as it were the keystone of three great faunal arches, eastern, western and southern, where in time past the birds from their respective regions approached so nearly, that a slight change in physical or climatic conditions would precipitate more intimate relations. Precisely such a state of affairs has happened, and the intermingling of races and

species on new territory has become permanent. In seeking a cause for this I am led to the belief that it is due chiefly to the introduction of cattle. When we remember that the growth of dense mesquite chaparral, which now forms such a marked feature in the landscape of southeastern Texas, and is steadily encroaching upon the tithe of open prairie yet remaining, is directly due to the grazing of immense herds of cattle which have, in their search for subsistence, robbed the prairie fire of its fuel and at the same time distributed the seeds of mesquite and other arborescent shrubs, this statement may not appear as paradoxical as it seems. The comparatively sudden conversion of many square miles of debatable ornithological ground from prairie to brush-land in this manner, would afford just such inducements to arboreal birds in the further extension of their winter range from the north and their summer range from the south as now exist. On the other hand, as the true prairie lands diminish, the more strictly plain-haunting species must disappear. A comparison of the relative abundance of the species noted by Beckham as compared with the same observed this year by Mr. Chapman and myself tends to prove this. Even in 1887, the date of Beckham's observations, Dr. Havard reports the mesquite as "shrubby" and Beckham characterizes it as "a dreary waste of cactus," etc. The growth of mesquite in the surrounding country, even since then, will tally well with the faunal changes recorded, for it must be borne in mind that until, say seven years ago, the overstocking of pasture with cattle and the consequent effect upon a previously superabundant pasturage did not affect the country far from city limits; so that beyond a comparatively small area surrounding the city, the virgin prairie retained its original features. For this reason birds were scarce, not so much because of drouth, but for lack of shelter and food suited to those of arboreal habits. Many insectivorous birds are found breeding in localities where water is unobtainable save in the form of dew, and, owing to the juicy nature of their food, they can most likely enjoy life indefinitely without the luxury of a drink. It seems therefore probable that the late increase of passerine birds in this part of Texas is due, not to an excess of rainfall, or to the absence of droughts in late years, but to the vast extension of tree-covered areas into the prairie and the increase of insect and vegetable food resulting from this cause; and these conditions apply not only to the increase of

individuals among old forms. but equally to the additional species now ascribed to the Corpus Christi fauna.

The subjoined list includes all birds observed by me; those species of which I did not obtain specimens being indicated by an asterisk. I wish here to acknowledge my grateful indebtedness to Mr. Witmer Stone, Conservator of the Ornithological Section of the Academy of Natural Sciences of Philadelphia, not only for receiving and caring for the collection during my absence, but also for invaluable aid in the identification of the material and in revising my notes.

TEXAS.

1. **Larus atricilla** Linn. Laughing Gull.

Common, breeding abundantly about Corpus Christi Bay. Nearly a third of those observed still retained the young, autumnal plumage of last year.

2. **Larus franklinii** Sw. & Rich. Franklin's Gull.

Five or six individuals of this exquisite gull were noted and one male was taken on the first of June. The female which accompanied it escaped me. The presence of this species at so late a date seems to corroborate Mr. Priour's assertion that a few remain to breed. The fly-catching habits of Franklin's Gull are noteworthy. I have seen a pair rise from a sand-bar, and proceeding directly to the mainland, begin to beat the chaparral in a most systematic manner for hours at a stretch, keeping meanwhile just out of gunshot, and leisurely gathering, in company with Henry's Nighthawk, the superabundant insect food which came in their way.

3. **Gelochelidon nilotica** (Hasselq.). Gull-billed Tern.

Breeding on the marshes but not common.

*4. **Sterna tschegrava** Lepech. Caspian Tern.

Common, but not found breeding in Nueces Bay.

5. **Sterna forsteri** Nutt. Forster's Tern.

Most abundant of the genus, and like its northern congeners, the first to proclaim and resent the presence of an intruder on its breeding grounds.

6. **Sterna antillarum** (Less.). Least Tern.

It is surprising that no one has recorded the Least Tern in Texas.[1] Priour assured me that before the destruction carried on a

[1] Merrill and Sennett found it breeding on sand-bars in the Rio Grande.

few years ago, the "Striker," as he calls it, was abundant. I found several skins of this species among some thousand millinery pelts collected in this locality by Messrs. Fancher and Noakes of Corpus Christi. On one occasion I noted a flock of a dozen flying near the town, and I rarely went to the bay without seeing three or four. From the action of these birds I judge they made their headquarters further south and were breeding.

7. **Hydrochelidon nigra surinamensis** (Gmel.). American Black Tern.

Saw this bird only at the mouth of the Nueces River, where one was secured, a full plumaged breeding male. Saw nearly a dozen altogether, always singly. This species is also heretofore unrecorded from the vicinity of Corpus Christi.

8. **Rhynchops nigra** Linn. Black Skimmer.

Abundant and breeding.

9. **Phalacrocorax mexicanus** (Brandt). Mexican Cormorant.

An immense flock of these birds was found sitting on the peninsular flats around the margin of an old pond. One individual shot from this flock was a young male of the year. These birds had evidently done breeding but just where they do breed, I was unable to discover.

10. **Anas fulvigula maculosa** (Senn.). Mottled Duck.

This is the commonest representative of its family on Nueces Bay in June, where it breeds in the marshes.

*11. **Spatula clypeata** (Linn.). Shoveller.

A few were observed at the mouth of the Nueces River.

72. **Ajaja ajaja** (Linn.). Roseate Spoonbill.

On the 28th of May, accompanied by Mr. Priour, I sailed down to the mouth of the Nueces River in search of these birds. At a distance of two miles a couple of large flocks could be descried as a dull rosy streak along the water's edge. We approached near enough to make, with the aid of a glass, an excellent survey of the flocks in the act of feeding before they noticed our presence. When within about two hundred yards of them, the whole company of four or five hundred individuals simultaneously raised their heads and faced about. On approaching some fifty yards nearer, the sudden righting about just mentioned was succeeded by a most interesting series of manœuvres, consisting of a contraction and filling in of all the gaps in the line; and just as this was

completed, with a rush of wings and a glorious burst of color, they arose. Many other detachments joined them until the entire flock numbered about six hundred. Most of these alighted some two miles off, while a few returned to their former feeding ground. All of these birds, including the young, were moulting. The adults were just shedding their brilliant scarlet patches, and their skins were bristling with pin feathers. Fully one-third were in the whitish plumage of the first year. According to Mr. Priour the Spoonbill attains its maximum plumage development some time in January, but he was unable to state whether this was due to a second moult in December, or whether there is merely a wearing away of the tips of the feathers as in *Agelaius* and other birds.

The Spoonbills now leave the vicinity of Corpus Christi the latter part of February, and though a few stragglers sometimes remain all the year, none have been known to breed on the Texas coast of late years. This state of affairs is probably due to their persecution and to the destruction of the forests between Corpus Christi and Brownsville which used to reach nearer the river mouths, affording this formerly abundant species suitable rookery sites.[1] It is probable that most of the flock of birds seen on Nueces Bay were raised somewhere on the coast south of Brownsville. After raising their young in comparative safety, they return yearly to this spot to spend the summer and early winter months, arriving in considerable numbers, even so early as the latter part of April, and attaining their maximum numbers in the latter part of May. Their evident attachment to the vicinity of Nueces Bay must be due to the facilities it affords them in the great item of food supply, for the reception accorded these birds by Corpus Christi gunners is far from encouraging.

13. Botaurus exilis(Gmel.). Least Bittern.

How this bird could have been overlooked by former observers I cannot conceive. Several were flushed in the marshes of Nueces Bay and two were secured, one of them a female with distended ovaries.

***14. Ardea herodias** Linn. Great Blue Heron.

One seen.

***15. Ardea egretta** Gmel. American Egret.

Three seen.

[1] Merrill and Sennet found a few in a l on heronry on the Rio Grande.

*16. **Ardea tricolor ruficollis** (Gosse). Louisiana Heron.

One of these birds was seen among the reeds at the mouth of the Nueces River.

*17. **Ardea virescens** Linn. Green Heron.

Several seen.

*18. **Nycticorax nycticorax nævius** (Bodd.). Night Heron.

Immense numbers of this species were found in the tall brake at the Nueces River mouth. The flocks were composed of young and old in every stage of plumage and had evidently resorted thither from some distant rookery, as no signs of nests could be found in the immediate vicinity.

*19. **Rallus elegans** Aud. King Rail.

A rail, presumably of this species, was flushed twice in the peninsular marsh near the city, but I failed to secure it.

20. **Recurvirostra americana** Gmel. Avocet.

Pairs and scattered individuals were seen throughout my stay. Mr. Priour states they breed in the vicinity.

21. **Himantopus mexicanus** (Müll.). Black-necked Stilt.

This clamorous and uneasy bird breeds abundantly in suitable places near Corpus Christi. Nests with eggs, but no young, were found.

22. **Tringa maculata** Vieill. Pectoral Sandpiper.

Three seen, one of which I secured.

23. **Tringa fuscicollis** Vieill. White-rumped Sandpiper.

Nearly a dozen of these wary birds frequented the salt ponds on the mainland shore of Nueces Bay. One was shot. This species does not appear to have been observed here before.

24. **Ereunetes pusillus** (Linn.) Semipalmated Sandpiper.

Small flocks were frequently seen and several specimens secured.

25. **Totanus melanoleucus** (Gmel.). Greater Yellow-legs.

A pair, evidently mated, were shot.

26. **Symphemia semipalmata inornata** Brewst. Western Willet.

Two specimens, probably referable to this race, were obtained. Willets were breeding, in limited numbers, on the city flats.

27. **Numenius longirostris** Wils. Long-billed Curlew.

Three were noted. They seemed to have done breeding.

28. Charadrius squatarola (Linn.). Black-bellied Plover.

The abundance of this Plover, so late as the seventh of June, in this neighborhood, is of interest.

29. Aegialitis vocifera (Linn.). Killdeer.

Not abundant.

30. Aegialitis semipalmata Bonap. Semipalmated Plover.

One seen.

31. Aegialitis wilsonia (Ord.). Wilson's Plover.

Breeding abundantly along the bay-side.

32. Arenaria interpres (Linn.). Turnstone.

My remarks on *Charadrius squatarola* apply with equal force to the Turnstone.

33. Colinus virginianus texanus (Lawr.). Texan Bob-white.

Abundant.

***34. Meleagris gallopavo** Linn. Wild Turkey.

Although I spent some time in the vicinity where Mr. Chapman secured his specimens, and visited well known turkey-roosts at night, I was unable to secure any of these birds.

35. Zenaidura macroura (Linn.). Mourning Dove.

Nowhere in the United States have I found this bird more abundant than in Texas. A dozen to twenty nests could be found in nearly every acre of chaparral, and frequently two nests would be found in the same mesquite bush.

***36. Cathartes aura** (Linn.). Turkey Vulture.

Abundant.

***37. Catharista atrata** (Bartr.). Black Vulture.

Saw two.

***38. Parabuteo unicinctus harrisi** (Aud.). Harris' Hawk.

The commonest species.

***39. Buteo lineatus** (Gmel.). Red-shouldered Hawk.

Found up the Nueces River.

***40. Falco sparverius** Linn. Sparrow Hawk.

Frequently seen.

***41. Polyborus cheriway** (Jacq.). Audubon's Caracara.

Comparatively abundant.

*42. **Pandion haliaetus carolinensis** (Gmel.). American Osprey.

Seen on two occasions near Nueces Bay.

*43. **Syrnium nebulosum** (Forst.). Barred Owl.

On the night of my encampment on the upper Nueces, the peculiar hooting of this owl indicated its abundance.

44. **Megascops asio mccallii** (Cass.). Texan Screech Owl.

Wherever the timber, either in the form of upland "Mottes" or riverside woodlands, was sufficiently heavy to afford a retreat, this owl was well represented.

45. **Crotophaga sulcirostris** Swains. Groove-billed Ani.

A specimen was collected about ten miles west of Corpus by Mr. Priour just previous to my visit. Another was seen on the second of June near the same spot.

46. **Geococcyx californianus** (Less.). Road Runner.

Breeding and common everywhere.

47. **Coccyzus americanus** (Linn.). Yellow-billed Cuckoo.

Frequently found and breeding.

*48. **Ceryle alcyon** (Linn.). Kingfisher.

Saw two.

49. **Dryobates scalaris bairdi** (Scl.). Baird's Woodpecker.

Abundant but shy.

50. **Melanerpes aurifrons** (Wagl.). Golden-fronted Woodpecker.

About Corpus Christi this bird is as abundant as the Flicker is in the east, and invariably builds in telegraph poles and high fence posts. In less settled parts they are rare.

51. **Antrostomus carolinensis** (Gmel.). Chuck Will's Widow.

A specimen was secured near Corpus Christi in April by Mr. Priour. I heard none during my stay.

52. **Nyctidromus albicollis merrilli** (Senn.). Parauque.

This Goatsucker was frequently heard throughout my stay, both at Corpus Christi and around San Patricio. Its monotonous, whistling "wee-ooo," is generally uttered while the bird is perched on a fence, though I have often traced it to the ground, both in the narrow cow-paths of the chaparral and in open glades. A nest, containing a single egg, nearly hatched, was found near San Patricio, on the first of June.

53. Chordeiles virginianus henryi (Cass.). Western Nighthawk.

All the Nighthawks shot around Corpus Christi appear to belong to this race. *C. texensis* finds its southwestern breeding limit about midway between Corpus Christi and San Antonio; during the migrations, however, *texensis* has been noticed by Priour a few miles west of Corpus Christi.

***54. Chaetura pelagica** (Linn.). Chimney Swift.

This species is another unaccountable omission from Beckham's list. Though not common, quite a number were seen.

***55. Trochilus colubris** Linn. Ruby-throated Humming-bird.

Three individuals seen.

56. Milvulus forficatus (Gmel.). Scissor-tail Flycatcher.

Very common but wary. These elegant birds moult in the summer, and by the first of June their bright colors are faded and the tail-feathers threadbare. Out of a dozen specimens obtained, there were no exceptions to this rule, though the breeding season had just begun. The worn appearance of the tail is largely due to the necessary switching of it in the devious pursuit of insect prey; but it may also be attributed to the fact that the birds are somewhat terrestrial in their habits, as I have observed them for hours gleaning insects in the open pastures and salt flats near Corpus Christi, alighting without hesitation in the short grass to secure or devour their food. I have also observed the males mounting and gyrating together in the air after the manner of Kingbirds.

57. Tyrannus tyrannus (Linn.). Kingbird.

The only specimen of this species seen, was obtained near Corpus Christi on May 30th.

58. Myiarchus crinitus (Linn.). Crested Flycatcher.

Two were noted, one of which was shot near the Nueces River bottoms, June sixth. Another specimen, shot at Corpus Christi April 10th, was obtained from Mr. Priour.[1]

[1] The latter specimen has a distinct dark band on the inner margin of the quill of the outer tail feathers, about equal in width to the entire outer web. Eastern birds frequently have a narrow band on the outer webs of the rectrices but I have never seen one quite so clearly marked as in the Texan example. The color of the under surface of the body in this specimen is, moreover, very dark, exceeding the average of eastern specimens in this respect. In connection with Texan species of *Myiarchus*, a specimen of *M. cinerascens* in the Academy collection, from Laredo ("Colln. Dr. H. B. Butcher, Aug. 17, 1866. ♀"), is perhaps worthy of mention as being the most eastern record of this species that I have seen. Prof. Cookes' "Bird Migration in the Mississippi Valley" where it is given on the authority of H. F. Peters, to be a summer resident at Bonham, fifty miles east of Dallas.—W. S.

59. Myiarchus mexicanus (Kaup.). Mexican Crested Flycatcher.

A pair of these birds had a nest and eggs near Priour's house.

60. Contopus borealis (Swains.). Olive-sided Flycatcher.

Two specimens were taken and about half a dozen seen. They were noticed as late as June 3rd.

61. Contopus virens (Linn.). Wood Pewee.

Common, and judging from its actions, a frequent breeder about Corpus Christi.

62. Pyrocephalus rubineus mexicanus (Scl.). Vermilion Flycatcher.

The eastern limit for the occurrence of this species lies about twenty miles west of Corpus Christi, in a country to all appearances identical with that nearer the town. The Texan Cardinal (*Pyrrhuloxia*), a bird of very different habits, confines itself during the breeding season to exactly the same limits, although it may be found during the winter and up to the first of May, about Corpus Christi.[1]

63. Otocoris alpestris giraudi Hensh. Texan Horned Lark.

Breeds commonly on the Corpus Christi flats. The song of this species is very deceptive often seeming to come from the ground before you, while in fact the bird is high overhead.

64. Molothus ater obscurus (Gmel.). Dwarf Cowbird.

Numerous everywhere.

65. Agelaius phœniceus (Linn.). Red-wing Blackbird.

Breeding abundantly in the marshes around Nueces Bay. Owing to the scarcity of water on the uplands this bird was rarely seen there.

66. Sturnella magna (Linn.). Meadow Lark.

Just as I was leaving Corpus Christi, a lark was brought to me in the flesh, which undoubtedly belonged to the eastern race. I was unfor-

[1] As Mr. Chapman has remarked, the Texas and Arizona specimens of Pyrocephalus are smaller than those from farther south and have smaller bills. In point of color there is considerable difference, as is shown in a good series of specimens. I have already called attention (Proc. Acad. Nat. Sci. Phil. 1890, p. 208) to the rosy or pinkish-red hue of Yucatan examples, as contrasted with the vermilion shade of those from other localities. Indeed, this difference seemed so constant that I was inclined to separate the former as a subspecies; an examination, however, of the material of the U. S. National Museum, which was kindly loaned to me through Mr. Robert Ridgway, shows that this idea was not supported. In the series of twenty-nine Mexican and Central American specimens now before me, four Yucatan specimens are pink, one is vermilion and one intermediate, while there is a bright pink specimen from Jalapa. Two Honduras birds show patches of orange-yellow on the breast.—W. S.

tunately unable to preserve it. I saw only three larks during my stay. They frequented the meadows of the bay and were excessively wild. I feel sure they were not *neglecta*, having on several occasions heard their song which had the unmistakable quality of *magna*. In this respect my experience corroborates that of Hancock whom Beckham thinks mistaken. The true state of affairs is probably that during winter the races intermingle, *neglecta* greatly predominating. Before the first of May *neglecta* decamps into the interior to breed and a few of the true *magna* remain.

67. Icterus spurius (Linn.). Orchard Oriole.

A few pairs found breeding.

68. Icterus galbula (Linn.). Baltimore Oriole.

None seen. A specimen, shot a few days before my visit, is in the collection.

69. Icterus bullocki (Swains.). Bullock's Oriole.

Several observed. Nest with young, June 2nd.

***70. Quiscalus quiscula æneus** (Ridgw.). Bronzed Grackle.

I observed this species industriously feeding its young along the San Antonio River. None seen nor heard of at Corpus Christi.

71. Quiscalus macrourus Swains. Great-tailed Grackle.

While very numerous at Corpus Christi, this Grackle attained a far greater abundance in the hack-berry mottes along the road to San Patricio, about fifteen miles west of Corpus Christi.

72. Ammodramus maritimus sennetti Allen. Texan Seaside Finch.

Found it common on the Nueces Bay flats.

73. Chondestes grammacus (Say). Lark Sparrow.

Breeding commonly. Fresh eggs and full-fledged young procured the same day, May 30th.

74. Peucæa cassini (Woodh.). Cassin's Finch.

Several found breeding in open pasture a mile from Corpus Christi.

***75. Melospiza fasciata** (Gmel.). Song Sparrow.

A few of these were seen but none secured.

76. Embernagra rufivirgata Lawr. Texas Sparrow.

As Mr. Chapman remarks, this species does not seem to have been recorded from north of the Rio Grande prior to his visit to Corpus Christi, and I think it most probable that twelve years ago it was

not a member of the fauna of this region. That it has become so since is easily accounted for by the facts already stated regarding the physical changes that have overspread the country in recent times. I found the Texas Sparrow thoroughly at home in the Corpus Christi and San Patricio chaparral, and secured their nests and fully fledged young.[1]

77. Cardinalis cardinalis canicaudus Chapm. Gray-tailed Cardinal.

I secured a series of fourteen specimens of this newly described race, including seven females and five males.[2]

78. Pyrrhuloxia sinuata Bonap. Texan Cardinal.

Though common in the vicinity of the town during winter and early spring this species retires twenty miles westward to breed.

79. Passerina ciris (Linn.). Painted Bunting.

Breeding abundantly everywhere.

80. Piranga rubra (Linn.). Summer Tanager.

Not found at Corpus Christi but several were observed in the heavy chaparral twenty miles west of it; also seen along the upper Nueces.

***81. Progne subis** (Linn.). Purple Martin.

Common in the vicinity of towns.

82. Petrochelidon lunifrons (Say). Cliff Swallow.

Plentiful, in flocks.

***83. Chelidon erythrogaster** (Bodd.). Barn Swallow.

Common. Breeding.

84. Cliviçola riparia (Linn.). Bank Swallow.

Very abundant.

***85. Stelgidopteryx serripennis** (Aud.). Rough-winged Swallow.

Observed a few with the preceding species.

***86. Lanius ludovicianus excubitorides** (Swains.). White-rumped Shrike.

Scarce.

[1] The young have the feathers of the head and interscapulum centered with black and bordered with ochraceous. Beneath, the breast and flanks are tinged with olivaceous and are marked with dark longitudinal markings; belly yellowish-white.—W. S.

[2] Two young females have the bills entirely black, as is the tendency in the young in this genus. There is a female specimen in the Academy's Collection which agrees exactly with Mr. Rhoads' birds and which was collected by Captain McCown at "Ringgold Barracks, Texas" in 1857.—W. S.

87. Vireo olivaceus (Linn.). Red-eyed Vireo.

A few were observed on the upper Nueces where they breed.

88. Vireo noveboracensis (Gmel.). White-eyed Vireo.

Common around Corpus Christi and elsewhere.

89. Vireo bellii (Aud.). Bell's Vireo.

Numerous, west of San Patricio where I found it breeding.

90. Dendroica æstiva (Gmel.). Yellow Warbler.

The only specimen observed was shot near Corpus Christi.

91. Seiurus noveboracensis notabilis (Grinn.). Grinnell's Water Thrush.

One specimen was procured.

92. Geothlypis trichas (Linn.). Maryland Yellow-throat.

A female shot was the only one certainly seen. Priour affirms that it breeds at the mouth of Nueces Bay.

93. Icteria virens (Linn.). Yellow-breasted Chat.

Only one of these birds, a singing male, was found. Merrill and Sennett found it abundant at Fort Brown, a fact which Beckham ignores. Mr. Priour thinks it a very rare summer resident around Corpus Christi.[1]

94. Mimus polyglottos (Linn.). Mockingbird.

Abundant breeder.

***95. Harporhynchus longirostris sennetti** Ridgw. Texas Thrasher.

Several of these birds were observed and were evidently breeding in the impenetrable chaparral near the town. I was unable to secure any.

96. Thryothorus ludovicianus (Lath.). Carolina Wren.

Only observed on the upper Nueces, where they are frequent and had fledged young.

97. Thryothorus bewickii bairdi (Salv. & Godm.). Baird's Wren.

Very numerous and prolific everywhere.

98. Parus atricristatus Cass. Black-crested Titmouse.

Several seen on the Nueces in large timber.

99. Auriparus flaviceps (Sund.). Verdin.

One specimen of the Verdin was secured. Although many of their nests were found, the breeding season was over and the old and young seemed to have left the country.

[1] This specimen seems intermediate in character, being quite as gray as the average *longicauda* but is little different in size from typical *virens*.—W. S.

100. Polioptila cærulea (Linn.). Blue-gray Gnatcatcher.

Only one seen.

The following, for various reasons appended, should be mentioned in this connection :—

Dendrocygna autumnalis (Linn.). Black-bellied Tree-duck.

Dendrocygna fulva (Gmel.). Fulvous Tree-duck.

Both these are mentioned in Dresser's and Merrill's lists, but not from any locality north of the Rio Grande. Mr. Priour says that both breed on the Nueces marshes, but produced no conclusive evidence.

Columba flavirostris Wagl. Red-billed Pigeon.

Another bird which Priour assures me straggles as far north as Corpus Christi in early spring.

Columbigallina passerina pallescens (Baird).

Mr. Priour says this dove breeds in the town.

Strix pratincola Bonap. Barn Owl.

I was shown several burrows in the face of a steep bank rising from Nueces Bay where this owl is said to breed regularly.

Speotyto cunicularia hypogæa (Bonap.). Burrowing Owl.

The complete disappearance of this common and characteristic bird from the region of Corpus Christi is directly due to the usurpation of their prairie domain by the now ubiquitous chaparral.

Ceryle cabanisi (Tschudi.). Texan Kingfisher.

This diminutive species, never common, seems to be growing rarer yearly. I made especial search for it on the Nueces, in a locality where it previously occurred, but without success.

"Ammodramus maritimus peninsulæ ?" Allen. Scott's Seaside-sparrow.

Mr. Chapman's remarks on this race, and the deductions made therefrom, may be somewhat simplified by the fact that I did not find any of the "black" Seaside Finches at the spot indicated, nor anywhere else in that vicinity, though special search was made. I am inclined to think Mr. Priour mistaken in his belief that these dark birds remain during the summer.

Arizona.

As already observed, my stay in southern Arizona covered the period between June 10th and July 12th, the first eight days being spent in the immediate vicinity of Tucson, the next twelve at Oracle,

in the live-oak belt on the southern slopes of the Santa Catalina Mountains, forty miles north of Tucson, and part of the remaining ten days in the pine-clad region of their summits, which rise some eight thousand feet above the Tucson level and five thousand above the elevation at Oracle. The country covered by my rambles included the central part of a larger area in Pima County, explored by Mr. W. E. D. Scott during a long residence in the Santa Catalinas. For a more thorough understanding of the region in question, and an excellent description of the natural characteristics of this part of Arizona, I cannot do better than refer to Mr. Scott's introductory paper "On the Avifauna of Pinal County," etc., published in the third volume of the "Auk."

As in the previous list, those in the subjoined, indicated by an asterisk, are not represented in the collection, no specimens having been secured.

*1. **Anas strepera** Linn. Gadwall.

While exploring the upper waters of the Santa Clara, four miles from Tucson, I found a duck feeding on the river and shot at it but failed to kill it. Shortly after it was secured by another gunner who was shooting in the vicinity and I was enabled to positively identify it. From Mr. Scott's account, it seems to be a rarity, even as a visitant, and this makes its occurrence in summer all the more noteworthy.

*2. **Ardea herodias** Linn. Great Blue Heron.

Rare.

*3. **Ardea virescens** Linn. Green Heron.

A few noted in the valley.

*4. **Gallinula galeata** (Licht.). Florida Gallinule.

A pair seen on Silver Lake, near Tucson.

*5. **Fulica americana** Gmel. American Coot.

Also seen on the Santa Clara River.

*6. **Aegialitis vocifera** (Linn.). Killdeer.

Not uncommon in the Santa Clara Valley.

7. **Callipepla squamata** (Vig.). Scaled Partridge.

Wherever found, the Scaled Quail was associated with Gambel's, both on the mesas and in the lower edge of the oak-belts. One was shot near the hotel at Oracle, but they rarely attain such an altitude, even in the breeding season, and are probably induced to wander away from their usual haunts in search of water which is

very scarce in June. Around Tucson I saw none of this species and not until I reached the lower mesa slopes did any appear. At no time was I sure of finding them until fairly below the oak belt. In numbers they ranked far below *C. gambeli*, not one in ten of all the partridges seen being *squamata*.

8. Callipepla gambeli (Nutt.). Gambel's Partridge.

I did not meet with any flocks of this species in the valley. They are very abundant in the oak belt, ranging as high as the lower pines and at the time of my visit were leading about their families of young, which varied in size from the newly hatched chick to half-grown birds. The male bird continues its harsh cry after the young have left the nest, and for sufficient reasons, too lengthy to be presented in this paper, I am convinced they are polygamous, whereas *C. squamata* is not.

***9. Cyrtonyx montezumæ** (Vig.). Massena Partridge.

Three "Fool Quails" were noticed on the higher slopes of the Catalinas, one of them at an elevation of 7000 feet.

The habits of the Massena Partridges are very dissimilar to those of the genus *Callipepla*, reminding one strongly of our eastern Bob-white in their aptness for quick concealment and sudden flight.

***10. Meleagris gallopavo mexicana** (Gould). Mexican Turkey.

Owing to a disastrous fire in the Mt. Lemon region of the Catalinas, this bird, once common, has wholly abandoned that part of the country. I did not see or hear of it elsewhere.

11. Columba fasciata Say. Band-tailed Pigeon.

Found well dispersed throughout the oak and pine belts and breeding in the latter. All nests examined contained either a single young or egg.

***12. Columbigallina passerina pallescens** (Baird). Mexican Ground Dove.

A few seen in the Tucson suburbs.

***13. Pseudogryphus californianus** (Shaw). California Vulture.

I was informed by Mr. Jack Alwinkle, a ranchman at Oracle, that he shot a "Condor" several years ago, near the summit of Mount Lemon. It was perched on a huge rock some distance from their camp, was shot to test the range of his rifle, fell dead, and, after a careless examination, was thrown away. Besides these facts, and his assertion that it was "twice as large as a buzzard," my

informant added that it was the only one he had seen since leaving California, where, as a cowboy, he had spent several years.

This statement of an excellent hunter and reliable observer should entitle this species to a place in the avifauna of Arizona.

***14. Cathartes aura** (Linn.). Turkey Vulture.

Fairly common up to 4000 ft.

15. Accipiter cooperi (Bonap.). Cooper's Hawk.

Several couples found breeding and young secured.

16. Buteo borealis calurus (Cass.). Western Red-tail.

Common. A pair found as high as 8000 ft.

17. Buteo abbreviatus Caban. Zone-tailed Hawk.

Some half-dozen noted, one at 9000 ft. elevation.

A nest with two young was found in a cañon near Oracle in a juniper.

***18. Buteo swainsoni** Bonap. Swainson's Hawk.

I came suddenly upon a pair of these Hawks sitting on the bank, at a bend in the Santa Clara, but they escaped before I could secure them.

***19. Aquila chrysaetos** (Linn.). Golden Eagle.

A pair were observed sitting on the crags which overlook the Cañon DeOro, above the trail to Mt. Lemon.

20. Falco sparverius Linn. Sparrow Hawk.

Abundant everywhere.

***21. Polyborus cheriway** (Jacq.). Audubon's Caracara.

Two were seen near Tucson and the species was occasionally noted near Oracle.

***22. Syrnium occidentale** Xantus. Spotted Owl.

On the opposite side of the Santa Clara valley at a point where there rises a rocky hill whose precipitous sides front the city of Tuscon, I found several of these owls. One pair was noticed perching on some large boulders and though they were in the full glare of the sun they did not appear at all disconcerted. From the appearance of the surroundings it seemed that these boulders were their regular stands, and this was rendered more likely as a nest from which a brood had evidently been raised was afterwards found in the recesses of a narrow ledge below where they had been sitting,

23. Megascops asio trichopsis (Wagl.). Mexican Screech Owl.

A young bird of this variety about two-thirds grown, was found in the chaparral near Tucson.

24. Bubo virginianus subarcticus (Hoy). Western Horned Owl.

Frequently heard but rarely seen. They are rare in the lowlands.

***25. Micropallas whitneyi** (Cooper). Elf Owl.

Though said to be numerous, none were met with.

26. Geococcyx californianus (Less.). Road Runner.

Found more abundantly near the oak-belt than in the vicinity of Tucson. I observed them also at a considerable distance above Oracle.

***27. Ceryle alcyon** (Linn.). Kingfisher.

Very few noted around Tucson.

28. Dryobates villosus hyloscopus (Cab.). Cabanis' Woodpecker.

Found sparingly at 8000 feet elevation among the pines.

29. Dryobates scalaris bairdi (Scl.). Baird's Woodpecker.

Common in the oak-belt and decreasing as you descend toward the plain.

30. Melanerpes formicivorus bairdi Ridgw. Californian Woodpecker.

Found breeding from the oak-belt upwards, to 9000 feet elevation.

31. Melanerpes uropygialis (Baird). Gila Woodpecker.

Co-extensive with the giant cacti.

32. Colaptes cafer (Gmel.). Red-shafted Flicker.

Only found in the pine woods and rare even there.

33. Colaptes chrysoides (Malh.). Gilded Flicker.

Tolerably numerous in the valley, but none seen elsewhere.

***34. Phalænoptilus nuttalli** (Aud.). Poorwill.

Abundant, and breeding in the oak belt.

35. Chordeiles texensis Lawr. Texan Nighthawk.

I found these birds abundant in the immediate vicinity of Tucson. They frequented the mesquite in preference to more open tracts and spent much of their time, even during the mid-day hours, in dashing about among the chaparral bushes for food, invariably lighting when tired in the shade of a bush or cactus. The song of this bird

has a wonderful resemblance to the distant hollow, rolling "whooooo" of *Megascops*. It is uttered by both sexes and whether they be on the ground or on the wing, the quality of these notes is so ventriloquial that I actually stumbled over three of the birds without taking notice of them, in the search for a supposed owl that I imagined I heard in a distant tree. On no occasion did they make any other sound which would show their intimate relationship to our *C. virginianus*.

***36. Micropus melanoleucus** (Baird). White-throated Swift.

A pair of these birds were certainly breeding in the cliffs where I found *Syrnium occidentale*, though I could not, because of the nature of the ground, make thorough enough search to discover the whereabouts of their nest.

I saw frequent companies of these birds in various places along the Santa Clara Valley, skimming the waters of Silver Lake and again sailing and twittering high in air, reminding one strongly, in both situations, of the Chimney Swift.

The day of my ascent of Mount Lemon, several of this species were seen coursing about the summit in company with Violet-green Swallows.

37. Eugenes fulgens (Swains.). Rivoli Humming-bird.

Soon after my arrival in the Catalina pine-belt I noted a large hummer, feeding among the yellow columbines of a little canon near the camp. I did not see it again until the day of my departure from the mountains, when I found it in the same place and upon shooting it found it to be an adult male of the above species. This is probably the most northerly record for the Rivoli Humming-bird and considering the time of its capture it seems quite likely that it was breeding in the vicinity.

38. Trochilus alexandri Bourc. & Muls. Black-chinned Humming-bird.

Very abundant in the Catalinas. One shot at Tucson and one at Oracle. The love antics of this bird are highly entertaining. Selecting an open space among the trees in the immediate vicinity of its nest the male starts from his perch among the willows uttering a shrill, continuous trilling note that bears a strange proportion in its tone and quickness to the varying rapidity of flight. Having reached the farthest limits of its chosen pleasure ground, at an elevation corresponding to that of the nearest tree-tops, it suddenly describes a headlong, parabolic curve, just grazing the ground and

rising with a diminishing cadence of voice and wings to the tree-tops on the opposite side where it repeats the manœuvre, regaining its former position. These evolutions are kept up in rapid succession, sometimes as many as thirty flights being taken with scarcely a rest. The geometric exactness of the curves which are traced by the bird is astonishing.

The nests of the Black-chinned Hummer are easily found, but my experience agrees with that of Mr. Scott regarding the scarcity of nests of the other humming-birds which inhabit the Catalina Mountains.

39. Trochilus platycercus Swains. Broad-tailed Humming-bird.

A common bird, associating with the former. I found a pair building in an oak tree beside a dry water-course but did not discover the nest until I had killed the female, whose body contained a well-developed egg.

40. Tyrannus verticalis Say. Arkansas Kingbird.

Found breeding from the plains to within a few hundred feet of the pines.

41. Tyrannus vociferans Swains. Cassin's Kingbird.

A few seen and two captured in the oaks near Oracle.

42. Myiarchus mexicanus magister Ridgw. Arizona Crested Flycatcher.

This bird was not common. It was not seen at an elevation of a thousand feet above Tucson.

43. Myiarchus cinerascens Lawr. Ash-throated Flycatcher.

Found well distributed and plentiful all the way from Tucson to the lower regions of the pine belt.

44. Sayornis saya (Bonap.). Say's Phœbe.

As uniformly distributed as the former though more common in the oak woods.

45. Sayornis nigricans (Swains.) Black Phœbe.

Seen only at Tucson and not common.

46. Contopus pertinax Cab. Coues' Flycatcher.

Only noticed in the pine belt where they were the most abundant Flycatcher.

47. Contopus richardsonii (Swains.). Western Wood Pewee.

Seen only in the pine but not common.

48. Empidonax difficilis Baird. Western Flycatcher.

Two nests with young and several mated pairs were observed in the Catalina pines.

49. Empidonax pusillus (Swains.). Little Flycatcher.

A pair were taken in a willow clump on the banks of the Santa Clara. They evidently had a nest but it was not found.

50. Pyrocephalus rubineus mexicanus (Scl.). Vermilion Flycatcher.

The greatest altitude at which I secured this Flycatcher was that of Oracle, nearly 6000 feet They were increasingly abundant as you neared the plains.

51. Otocoris alpestris adusta Dwight. Scorched Horned Lark.

Horned Larks were not abundant, though I frequently observed small companies on the higher plains and mesas between Tucson and the oak belt. I succeeded in securing but one, a young bird, fully fledged.

52. Cyanocitta stelleri macrolopha (Baird). Long-crested Jay.

This species was confined strictly to the pine belt during my stay. Its scolding is a peculiar combination of hiss, snarl and sneer.

53. Aphelocoma woodhousei (Baird). Woodhouse's Jay.

Only three of these wary birds were noted, all within a mile of Oracle, in the oak belt.

54. Aphelocoma sieberi arizonæ Ridgw. Arizona Jay.

The strict coincidence of the range of this abundant species with the limits of the oak belt is as remarkable as that of the Long-crested Jay with the pines.

55. Corvus corax sinuatus (Wagl.). American Raven.

Several Ravens visited the water tank and corral at Oracle daily, and I occasionally saw them soaring among the foothills.

56. Corvus cryptoleucus Couch. White-necked Raven.

The above remarks equally apply to this species, with the difference that the former generally betook themselves to higher altitudes while the latter departed down the nearest cañon toward the San Pedro.

57. Molothrus ater obscurus (Gmel.). Dwarf Cowbird.

Numerous in the valley and occasional around Oracle.

58. Agelaius phœniceus sonoriensis Ridgw. Sonoran Red-wing?

These Blackbirds were fairly numerous along the water-courses of the Santa Clara.[1]

59. Icterus parisorum Bonap. Scott's Oriole.

Frequently found leading their young among the oaks around Oracle and 1000 feet higher. A pair were also seen in the mesquite bordering the oak belt.

60. Icterus cucullatus nelsoni Ridgw. Arizona Hooded Oriole.

While the range of this species extends from Tucson nearly up to the lower edge of Catalina pines it was nowhere so abundant as in the oak belt.

61. Icterus bullocki (Swains.). Bullock's Oriole.

None seen in the Catalina region but abundant in the heavy chaparral of the Santa Clara Valley, where they breed. By imitating the cry of a young bird and concealing myself in the bushes I never failed to bring a crowd of these usually timid birds within easy range.

62. Carpodacus mexicanus frontalis (Say). House Finch.

Very abundant to near the lower pine limit; males singing, and young in every stage of growth. Some of their call notes, and their actions and habits in general, are very suggestive of *Passer domesticus*.

63. Spinus psaltria arizonæ (Coues). Arizona Goldfinch.

Several rather large flocks were seen about Tucson and a small one in the oak belt; two specimens were secured.

64. Chondestes grammacus strigatus (Swains.). Western Lark Sparrow.

Found rather sparingly in the oak belt but nowhere else.

65. Junco cinereus palliatus Ridgw. Arizona Junco.

Breeding abundantly in the pine belt.

66. Amphispiza bilineata (Cass.). Black-throated Sparrow.

Ranging commonly, and breeding from Tucson to 1000 feet above Oracle.

[1] Mr. Scott makes no allusion to this Blackbird in his paper, the only species of *Agelaius* mentioned being *A. gubernator* (Auk 1887, p. 22). Only one specimen, an adult male is contained in Mr. Rhoads' collection so that it is difficult to decide to which race it should be referred. The measurements seem to be nearer to true *phœniceus* rather than to *sonoriensis*, the wing being 4·80 in.—W. S.

67. Peucæa arizonæ Ridgw. Arizona Sparrow.

This species frequented the thick bunches of bear-grass just below the lower edge of the oak belt; they were breeding and were very shy. Their habits are eminently terrestrial, and at no time did they leave the ground save to perch on the lowly bear-grass stems and utter a rather sweet song. Four individuals were seen, all within a hundred yards of each other. Three were secured. Nowhere else did I see or hear this species, though a most careful search was made in the neighborhood. It is not mentioned in Mr. Scott's paper.

68. Peucæa ruficeps boucardi (Scl.). Boucard's Sparrow.

Sparingly distributed throughout the oak belt and lowest portion of the pine belt.

69. Melospiza fasciata fallax (Baird). Desert Song Sparrow.

Found breeding only in the near vicinity of water in the Santa Clara Valley.

70. Pipilo maculatus megalonyx (Baird). Spurred Towhee.

Common in the pines and ranging up to the mountain tops.

71. Pipilo fuscus mesoleucus (Baird). Canon Towhee.

Abundant in the forest-clad areas as far up as the oaks reach into the pines. The resemblance of this bird's song to certain notes in the Cardinal's repertory is remarkable.

***72. Pipilo aberti** Baird. Abert's Towhee.

This species very sparingly replaces the preceding in the neighborhood of Tucson.

73. Cardinalis cardinalis superbus Ridgw. Arizona Cardinal.

One pair of these were secured at Tucson. No other seen.

74. Pyrrhuloxia sinuata beckhami Ridgw. Arizona Pyrrhuloxia.

A few were seen near Tucson in the chaparral of the Santa Clara Valley.

75. Habia melanocephala (Swains.). Black-headed Grosbeak.

Found breeding abundantly in the Catalina pines up to very high altitudes.

76. Guiraca cærulea eurhyncha Coues. Western Blue Grosbeak.

In the valley of the Santa Clara about Tucson this Grosbeak was daily seen. I shot a male and female which were carrying building material into a willow thicket on the river bank.

*77. **Passerina amœna** (Say). Lazuli Finch.

One seen near the railroad station, Tucson.

78. **Piranga ludoviciana** (Wils.). Louisiana Tanager.

Fairly common in the Catalina pines.

79. **Piranga hepatica** Swains. Hepatic Tanager.

In the same locality as the former but less common. Also found in the upper oak belt.

80. **Piranga rubra cooperi** Ridgw. Cooper's Tanager.

Ranges between the central portion of the oak belt and the Santa Clara Valley but is not common.

81. **Progne subis hesperia** Brewst. Western Martin?

Abundant in the lowland regions, particularly about Silver Lake.[1]

*82. **Chelidon erythrogaster** (Bodd.). Barn Swallow.

Observed on the foothills but not in the valley.

83. **Tachycineta thalassina** (Swains.). Violet Green Sparrow.

Abundant on the Catalina mountain tops where it breeds in holes like its eastern congener, *T. bicolor*.

*24. **Clivicola riparia** (Linn.). Bank Swallow.

85. **Stelgidopteryx serripennis** (Aud.). Rough-winged Swallow.

These two species were found associated along the higher banks of the Santa Clara in the Tucson suburbs, the latter being the more numerous.

86. **Phainopepla nitens** (Swains.). Phainopepla.

Uniformly distributed throughout all the region traversed, up to 6000 feet.

87. **Lanius ludovicianus excubitorides** (Swains.). White-rumped Shrike.

Tolerably abundant from the lowlands upward as far as Oracle.

88. **Vireo gilvus** (Vieill). Warbling Vireo.

A pair of these birds were found nesting in a maple on Mt. Lemon at 8000 feet.

89. **Vireo solitarius plumbeus** (Coues). Plumbeous Vireo.

In the pine belt of the Catalinas I found the Plumbeous Vireo tolerably abundant. In habits it reminded me of *V. solitarius*,

[1] Only one specimen, a young male, was secured by Mr. Rhoads and it is impossible to determine its affinities with certainty, though it seems to approach this race.—W. S.

especially in its fondness for the tops of the highest evergreens. The song is noticeably different from that of our eastern bird, despite a resemblance.

***90. Vireo bellii pusillus** (Coues). Least Vireo.

The Least Vireo was found sparingly in the chaparral of vacant lots around Tucson and in similar places in the Santa Clara Valley. Independently of the taxonomic differences which may warrant Mr. Ridgway's claim to full specific rank for this Vireo, there is nothing in its song or habits to support this position.

91. Vireo vicinior Coues. Gray Vireo.

Frequent in the oak-woods and nowhere else.

92. Helminthophila luciæ (Cooper). Lucy's Warbler.

Abundant from Tucson upward to a few hundred feet above Oracle.

93. Helminthophila virginiæ (Baird). Virginia Warbler.

Little companies of this species frequented the deciduous trees in the lower edge of the Pine-belt, reminding me in their habits of the Bush Tits and Titmice with which they associate.

***94. Dendroica olivacea** (Giraud.). Olive Warbler.

I saw one of these birds in the mountains but failed to secure it. It was in full view and its peculiar habit of perching on the large pines branches near the trunk, its deliberate movements and characteristic markings, examined with a glass at short range, convince me of the correctness of my identification.

96. Dendroica æstiva sonorana Brewst. Sonora Yellow Warbler.

Plentiful around Tucson in the valley but seen nowhere else.[1]

96. Dendroica auduboni (Towns.). Audubon's Warbler.

Not rare in the Catalina among the pines.

97. Dendroica graciæ Coues. Grace's Warbler.

Abundant in the pines.

98. Dendroica nigrescens (Towns.). Black-throated Gray Warbler.

Abundant in the pines.

[1] A young bird of this race in the collection is silky white beneath, with the lores and sides of the throat light yellow; above gray, the lesser wing coverts and rump yellow-olive, greater wing coverts edged with buff, wings and tail as in adults. The specimen was evidently moulting, as yellow pin feathers are to be seen here and there on the breast.—W. S.

99. Geothlypis trichas occidentalis Brewst. Western Yellow-throat.

Sparingly found in the immediate vicinity of running water around Tucson.

100. Icteria virens longicauda Lawr. Long-tailed Chat.

Abundant in the valley.

101. Setophaga picta (Swains.). Painted Redstart.

This exquisite species was common in the Catalina pine woods and the upper edge of the oak belt.

102. Cardellina rubrifrons (Giraud). Red-faced Warbler.

The above remarks apply equally to this species, though its range does not extend so far up as that of the Redstart.

103. Mimus polyglottos Linn. Mockingbird.

Without exception the most abundant bird in the country, ranging up to 5000 or 6000 feet.

104. Harporhynchus curvirostris palmeri Ridgw. Palmer's Thrasher.

To the best of my recollection Palmer's Thrasher was the commonest species of the genus, ranging somewhat lower than the following.

105. Harporhynchus bendirei Coues. Bendire's Thrasher.

Found abundantly from the plains up to 4000 feet.

106. Harporhynchus crissalis (Henry). Crissal Thrasher.

Equal in abundance and with a similar range to *H. bendirei*.

107. Campylorhynchus brunneicapillus (Lafr.). Cactus Wren.

Abounding in all dry situations between Tucson and Oracle.

108. Salpinctes obsoletus (Say). Rock Wren.

Tolerably common in rocky situations within the oak belt. A pair observed on top of a spur of Mt. Lemon, 8000 feet high.

109. Catherpes mexicanus punctulatus Ridgw. Dotted Cañon Wren.

The first of these enchanting songsters was heard among the rocks of a hill near Tucson, around which flowed the waters of the Santa Clara. They were rare in this locality. I next discovered them in the boulder-covered foot-hills about Oracle and found them breeding in the Santa Catalinas, one pair having located in a pile of rocks several hundred feet above our camp.

110. Thryothorus bewickii bairdi (Salv. & Godm.). Baird's Wren.

Throughout the oak belt and for some distance in the pines this species was very common. I did not find any at a lower elevation.

111. Troglodytes aedon azteeus Baird. Western House Wren.

Very common in the pine clad areas of the Catalinas where its range overlaps that of Baird's Wren.

112. Certhia familiaris mexicana (Glog.). Mexican Creeper.

A few were noted in the higher pines on Mt. Lemon 7000 to 8000 feet.

113. Sitta carolinensis aculeata (Cass.). Slender-billed Nuthatch.

Very common throughout the pines to the highest mountain tops.

114. Sitta pygmæa Vig. Pygmy Nuthatch.

Co-extensive with preceding species and even more abundant.

115. Parus wollweberi (Bonap.). Bridled Titmouse.

Abundant in the oak-belt and lower edge of pine belt.

116. Parus gambeli Ridgw. Mountain Chickadee.

Found on the Catalina mountains in flocks, at and above 7000 feet; always in the tops of the lofty firs.[1]

117. Psaltriparus plumbeus Baird. Lead-colored Bush-Tit.

Found everywhere, within the limits of the oak belt.

118. Auriparus flaviceps (Sund.). Verdin.

While I occasionally saw the Verdin in the fringe of the oak growth, it became increasingly numerous as I neared Tucson where it was abundant.

***119. Regulus satrapa olivaceus** Baird. Western Golden-crowned Kinglet.

I found a male of this species among the fir tops near the summit of Mt. Lemon. It continued to utter a sweet song while I watched it through my glass.

120. Polioptila cærulea obscura Ridgw. Western Gnatcatcher.

Breeds in the lower edge of the pines, not common.

121. Polioptila plumbea Baird. Plumbeous Gnatcatcher.

Common everywhere among the foot-hills and higher uplands but rare in the valleys. In the lower pine belt it is replaced by the other species.

122. Turdus aonalaschkæ auduboni (Baird). Audubon's Hermit Thrush.

These thrushes sang continuously during my ascent of Mount Lemon, answering each other from the opposing cañons with the same measured cadences and pauses that characterize the song of

[1] This species does not seem to have been previously recorded from this district.—W. S.

pallasii. This was on the first day of July, and from what I observed, they were abundant and the breeding season was at its height.

***123. Merula migratoria propinqua** Ridgw. Western Robin.

A small number found breeding among the Catalina pines.

124. Sialia mexicana Swains. Western Bluebird.

Abundant in the pine belt at all elevations.

The following were accidentally omitted from their proper place in the list.

Zenaidura macroura (Linn.). Mourning Dove.

Oracle and Tucson.

Melopelia leucoptera (Linn.). White-winged Dove.

Tucson.

FEBRUARY 2.

The President, General ISAAC J. WISTAR, in the chair.

Forty-seven persons present.

A paper entitled "The Development of the Shell in the coiled stage of Baculites compressus Say," by Amos P. Brown was presented for publication.

The death of Andrew H. Miller a member, January 29, was announced.

Drexelia, a New Genus of Spiders.—REV. H. C. MCCOOK, D. D. stated that Mr. Cambridge had described, under the name of *Epeira tetragnathoides*, a species of spiders which without doubt is identical with *Epeira directa* of Hentz. The late Count Keyserling in his manuscript notes as edited by Dr. George Marx, applies the name of *Epeira deludens* to the same species, and it is so catalogued, *in litteris*, by Dr. Marx in his Catalogue of North American Araneæ. Specimens in the speaker's collection, which are beyond doubt identical with Hentz's *Epeira directa*, have been carefully compared with specimens in the Marx collection, identified by Keyserling as his *Epeira deludens*, and both, again, with the descriptions of *E. tetragnathoides* by Cambridge in "Biologia Centrali Americana."

Not only is the specific name of Hentz thus restored, but it becomes necessary to make this species the type of a new genus, which Dr. McCook had named *Drexelia*, in recognition of the noble contribution to scientific and industrial education made by our fellow townsman, Mr. Anthony J. Drexel. *Drexelia* is separated sharply from *Epeira* by the peculiar elongated shape of the sternum, which is at least twice as long as wide; and further, by the character of the maxillæ, which are longer than wide; and still further by the shape of the abdomen, which is long, narrow, straight, and, especially in the female, somewhat compressed both at the base and the apex. The legs, too, are less stout than those of the typical *Epeira*. In the form of the maxillæ *Drexelia* approaches both *Nephila* and *Meta*, but differs from both and in a more marked degree from *Epeira*, in relatively greater length of the sternum. It differs also from these genera in the form of the abdomen, that of *Nephila* being long as in *Drexelia*, but sub-cylindrical in form; that of *Meta* being a rounded oval, approaching thus the typical *Epeira*. In the shape of the abdomen *Drexelia* somewhat resembles *Tetragnatha*, a fact which doubtless suggested the name given by Cambridge. It also approaches this genus in the rather slight and feebly armed character of the legs; but the mouth parts and rnum, to nothing of other characteristics, widely divide th two ge a. *Drexelia* approaches *Epeira* in the contour of the s ad,

and resembles examples of the same species in the grouping of the eyes; but in all other respects it is so widely divided from the typical *Epeira*, that it becomes necessary to separate it from the genus; and, as he knew of no other to which it can be relegated without equal objections, he had deemed it necessary to establish for it this new genus.

DREXELIA DIRECTA Hentz.

1847 *Epeira directa*, Hentz. Jour. B. S., Nat. Sci., V, Pl. 31, fig. 21; and U. S. p. 119, Pl. 13, fig. 21.
1847 *Epeira rubella* Hentz Ibid, fig. 22; Ibid, p. 120, fig. 22.
1889 *Epeira tetragnathoides* Cambridge. Biolog. Cent. Am., Aran. p. 16, Pl. viii. figs. 9, 10.
1890 *Epeira deludens* Marx, *in litt.*, Catalg. p. 544. (Keyserling Die Spinn. Am. IV, Epeir.)
1890 *Singa rubella* (Hz.) Marx. Ibid, p. 547.

FEBRUARY 9.

The President, General ISAAC J. WISTAR, in the chair.

Forty-six persons present.

FEBRUARY 16.

The President, General ISAAC J. WISTAR, in the chair.

Thirty persons present.

Papers under the following titles were presented for publication:—

A new Pycnogonum from the West Coast of the United States. By J. E. Ives.

Birds collected by the West Greenland Expedition of 1891. By Witmer Stone.

Anatomy of West Indian Helices.—MR. H. A. PILSBRY stated that the genital system in the Helices belonging to the genus *Caracolus* is characterized by its simplicity, resembling the North American genus *Polygyra* in this respect. It differs from this last in several points, notably in the presence of a flagellum upon the penis; or, to speak more exactly, upon that slender continuation of the penis which gives rise to both the flagellum and the *vas deferens*. In *Caracolus rostratus* (Pl. VI, figs. C, D) the flagellum (fl.) is very short; the duct of the spermatheca being likewise short. The jaw (Pl. VI, fig. E) is stout, its central portion arching forward like a beak, with the suggestion of a median prominence to the cutting edge. It is completely devoid of ribs, although some other forms of *Caracolus* which are scarcely distinguishable specifically from this

one, are strongly odontognathous, another proof that this character is worthless for dividing genera or sections among the Helices.

Caracolus (*Lucerna*) *acutus* (Pl. VI, fig. A.) has a short flagellum, but much longer than that of *C. rostratus*. The duct of the spermatheca is long. The jaw (Pl. VI, fig. B) has strong, unequal ribs.

Hemitrochus (*Plagioptycha*) *salvatoris* has the same type of jaw which Binney has described and figured for *H. varians* the typical species of *Hemitrochus*. In the present species, which belongs to the section *Plagioptycha*, the jaw (Pl. VI, fig. G) is highly arched, has a feeble median projection, and a group of faint vertical striæ in the middle. The genital system (Pl. VI, fig. F) is complicated by the presence of a large dart sac, several unequal accessory glands, (*a. gl.*) corresponding to the "digitate glands" of the restricted genus *Helix* (*H. pomatia*, etc.). The penis (*p.*) is slender and twisted. It bears a long flagellum of the "whip-lash" type. I found no retractor muscle attached to the penis, but I suppose that there is one.

I have not commented on or figured the teeth of these forms, as Binney has already investigated those of numerous allied species.

These few species serve to show the marked difference existing between the genital systems of the two main genera of West Indian Helices:—*Caracolus* and *Hemitrochus*.

Explanation of Plate VI.

A. Genitalia of *Caracolus* (*Lucerna*) *acutus* Lam. drawn from a specimen collected by Wm. Fox, in Jamaica (Mus. No. of shell, 61,632.)
B. Jaw of the same.
C. Genitalia of *Caracolus rostratus* Pfr., (Cuba), obtained from a bunch of bananas.
D. Same specimen, from the opposite side.
E. Jaw of the same specimen.
F. Genitalia of *Hemitrochus* (*Plagioptycha*) *salvatoris* Pfr. Drawn from a specimen furnished by Wm. H. Dall. (Mus. No. of shell, 62,941). Wattlings Id., Bahamas.
G. Jaw of the same individual.
(*P.* penis, *fl.* flagellum, *p. r.*, retractor penis, *r. s.* spermatheca, *a. gl.* accessory glands.

FEBRUARY 23.

The President, General ISAAC J. WISTAR, in the chair.

Thirty-two persons present.

The death of Henry Walter Bates, a correspondent, February 17, was announced.

The following were elected members:—

Walter Horstmann, Charles S. Boyer, John M. Hutchinson, S. Emlen Meigs and Simon J. Martin.

Howard Ayres of Milwaukee was elected a correspondent.

The following were ordered to be printed:—

NEW AND UNFIGURED UNIONIDÆ.

BY H. A. PILSBRY.

Unio Quintardii Cragin. Pl. VII, figs. 1, 2, 3.

This plicate *Unio* presents characters which separate it easily from the numerous waved species of the Mississippi basin. The sculpture consists of a series of superimposed v-shaped waves, the apices of the V's directed towards the beaks. There are some of the narrow, impressed furrows, crossing the waves at right angles, which form so prominent a character of the sculpture of *Unio undulatus* Barnes. The cuticle is dark-brown with occasional blackish streaks, as in other shells of the same group. The beaks are eroded and the nacre white. Other characters are shown in the figure, which is drawn from the original type.

This species is from Salt Creek, a tributary of the Deep Fork of the Canadian river, Sac and Fox Reservation, Oklahoma Territory.

A description of this shell was published by Prof. F. W. Cragin, in the Bulletin of the Washburn College Laboratory of Natural History, II, No. 8, p. 6, October, 1887. It has not before been figured.

Unio Pilsbryi Marsh, Plate VIII, figs. 7, 8.

Like the last species, this is a member of the plicate group of Uniones. It is a decidedly compressed, oblong shell, black in color, having very distinctly marked lines of growth, which are spaced over the greater part of the disc, but become crowded on the lower margin. It has numerous oblique waves, which generally bifurcate indistinctly toward the posterior-lower end. The waves are more or less cut by short impressed furrows, as in *U. undulatus*, etc. The nacre is white and very thick anteriorly, but in the cavity of the valves and posteriorly it is thin and stained with blue and olive-green. The lateral teeth are also olive-green. This species was collected by Mr. Elwood Pleas in the Little Red River, Arkansas. It has been described by Mr. Wm. A. Marsh in the "Nautilus," V. p. 1.

Unio Pilsbryi is not closely allied to any other American species. It has a striking resemblance to *Unio Leai* Gray of China.

Specimens, including the individual figured, are in the exhibit of United States shells in the Museum of the Academy of Natural Sciences of Philadelphia.

Arconaia Provancheriana Pilsbry, Pl. VII, figs. 4, 5, 6.

This species has already been briefly noticed in these Proceedings, and a description has been published in the "Nautilus," IV, p. 127. It may be compared in the degree and direction of twist to the variety of *Arconaia contorta* Lea, figured by Heude on Pl. XV, fig. 32, of his "Conchyliologie fluviatile de la Province de Nanking et de la Chine Centrale," a Chinese species. The locality of this species is not known positively, but it is supposed to be from China. The type is No. 63,094 of the collection of the Philadelphia Academy.

The *Arconaia Delaportei* of Crosse and Fischer (Journal de Conchyliologie, 1876, Pls. X and XI,) differs decidedly from the present form in outline, and in the winged extremities. *A. Provancheriana* may, indeed, prove to belong elsewhere than in *Arconaia*, as it is not at all produced at the ends, as are the species hitherto included in that genus or subgenus.

REPORT ON THE HYMENOPTERA COLLECTED IN WEST GREENLAND.

BY WILLIAM J. FOX.

The Hymenoptera enumerated in the present paper were collected by Messrs. Mengel and Hughes, who accompanied the Academy's recent expedition to West Greenland. The larger portion of the collection was made at Disco Island, in lat. 69° 10′ and at McCormick Bay, Lat. 77° 40′ while Herbert Island, Lat. 77° 30′ contributes one specimen. The species of *Nematus* described below was forwarded to Mr. C. L. Marlatt of the U. S. Department of Agriculture, a specialist to whom I am indebted for the description. My thanks are due Prof. Angelo Heilprin and to Mr. E. T. Cresson for the opportunity of studying the collection.

TEREBRANTIA.

Nematus borealis Marlatt, n. sp.

♂ —Black, including the tegulæ and trophi; labrum, tip of abdomen, tips of femora, tibiæ, tarsi except tips and posterior pair dull yellowish or resinous. Antennæ moderately long and slightly flattened; joints three to five, nearly equal; all coarsely punctured and faintly pubescent. Head more angular than is commonly the case in *Nematus* and resembling in this respect the genus *Dolerus* and in *Nematus, N. concolor* and particularly *rapax*; when viewed from above, sloping regularly and considerably posteriorly; sparsely pubescent; region including ocelli abruptly elevated or shield-shaped—the posterior ocelli on border of shield and the anterior ocellus in the wide basin of the shield; clypeus slightly emarginate, shining. Scutellum and lateral lobes of the mesothorax shining. Abdomen with central longitudinal ridge above on posterior half. Wings perfectly hyaline, veins dark-brown, including costal to base; stigma large, yellow; second submarginal cell uniform in width, *i. e.*, not especially widened at first angle; distance of first recurrent nervure from base of second cell not twice that of second from tip. Inner tooth of claw large but somewhat smaller than outer tooth.

Length ·25 inch (6mm.)

Expanse ·60 inch (14mm.)

Described from a single ♂ from Disco Island. This species is allied to, but readily distinguished from *concolor, rapax* and *labradoris.*

Ichneumon discoensis n. sp.

A specimen from Disco Island, August 10th, does not agree with any of the species heretofore recorded from Greenland or Arctic America.

The following description will aid in distinguishing it: Black; the apical half of the femora, the tibiæ, tarsi, the apex of the first, the second and third entirely and the base of the fourth abdominal segments, above and beneath, and a spot on the scutellum, reddish brown; the tips of fore tibiæ and the apical tarsal joints dark; head and thorax clothed with short, black pubescence, finely and evenly punctured; clypeus truncate; antennæ situated at a point opposite the middle of the eyes, much shorter than the body, entirely black, 38-jointed, the scape short and stout, hirsute beneath; wings subhyaline, with a violaceous reflection, the nervures and stigma black; metathorax strongly punctured, rugose on the sides, the posterior face enclosed by a very strong ridge, bicarinated; the upper surface bears four ridges, the two inner ones by far the shortest, all four being connected with the ridge enclosing the posterior face; at the top of the metapleuræ there is another strong, curved ridge, which extends nearly to the posterior coxæ; femora finely punctured; abdomen with fine close punctures, the third segment depressed at base. Length about 11·5mm.

Exolytus sp.?

A small species with the head and thorax black, the four anterior legs except the coxæ and trochanters, the hind legs from the apex of the femora, all brownish.

Disco Island, August 10th.

Cryptus arcticus Schiodte.

Four ♀ specimens, Disco Island, August 10th., agree with the description of this species.

ACULEATA.

Bombus nivalis Dhlb.

Two ♂ specimens. McCormick Bay, July 27th.

Bombus derhamellus Illig.

Two ♂ specimens. Herbert Island, July 24th; McCormick Bay, July 27th.

Bombus sp.?

A specimen in very poor condition from Disco, June 27th, from present appearances seems to have had the prothorax, scutellum,

the first three and last two abdominal segments, dorsally, with yellow pubescence; the inner side of first joint of posterior tarsi with brownish, glittering pubescence; otherwise black.

Bombus hyperboreus Dhlb. (=*arcticus* Kirby.)

This species appears to have been the most abundant. In all four ♀ and six ♂ specimens were obtained. Disco Island, June 27th., three ♀'s, August 10th., six ♂'s. One specimen a female, has the yellowish pubescence much paler than in the other specimens of this sex.

Bombus sp.?

Two ♂ specimens. Disco Island, August 10th. I have been unable to identify these specimens with any of the known species of Europe and America. The great variation to which representatives of this genus are subject and the lack of European material at hand, renders it unsafe to describe these as new.

THE DEVELOPMENT OF THE SHELL IN THE COILED STAGE OF BACULITES COMPRESSUS SAY.

BY AMOS P. BROWN.

In a former brief communication[1] the writer has noted the discovery of the young of the above species in some Cretaceous marl from near Deadwood, S. Dak., and has shown that *Baculites* was coiled in its earlier stages. In the same communication the development of the suture is illustrated from a generalized Ceratite stage to the adult suture of *B. compressus*, thus fixing the species of these young forms. Since the above was communicated the writer has been engaged in the study of the development of the shell in the coiled stage and the results of these investigations are presented herewith.

The coiled stage of the shell consists of two to two and one-half whorls, the diameter of this coiled portion being 0·8 to 1· mm. The shell then passes at once into the straight form, either tangent to the spiral or somewhat reflexed in certain cases. By breaking the shell back from the straight portion to the protoconch, the development of the shell was made out and the successive stages in this development observed. By an examination of the surface markings of the shell the form and extent of the embryonic shell on leaving the egg—the first næpionic stage—has been determined with considerable certainty.

The protoconch appears on a front view broadly elliptical in outline, being 0·55 mm. to 0·60 mm. in axial diameter by 0.45 mm. in vertical diameter; this axial diameter then diminishes in each succeeding whorl and is not again attained until a length of several millimeters of the straight portion of the shell has been developed. Hence the rounded ends of the protoconch may generally be seen projecting beyond the succeeding whorls when the entire spiral portion of the shell is viewed edgewise. The suture line of the first septum is marked by the prominent narrow saddle over the siphuncle which determines that this form belongs to the Angustisellati of Branco. The remainder of the first septum is rather simply curved, the lateral saddles of the succeeding septa being perhaps represented by the slight lateral undulations that exist. Seen from the side the protoconch has the form shown in Pl. IX, fig. 4, while

[1] Proc. Acad. Nat. Sci., Phila., 1891, pp. 159–160.

the front view is shown in fig. 3. In this latter the form of the septum may be readily seen, and also the position of the siphuncle. It will be noticed that the perforation of the siphuncle is large (0·07 mm. in diameter), this diameter of the perforation remains quite constant throughout the spiral portion of the shell. The form of the first septum is lunate, 0·55 mm. broad by 0·15 mm. high and the lateral extremities reach to near the axis of the spiral. The next following septa have successively smaller lateral diameters and larger vertical diameters, so that the successive whorls become rapidly less and less enveloping. The form of the septa at the same time is gradually changing; the lunate form of the first septum gives place to a broadly elliptical form concave on the inner side; this in turn passes into a more and more circular form, until it becomes completely circular in the straight portion of the shell. Thus Plate IX, fig. 8, shows the fourth septum to be 0·52 mm. broad by 0·21 mm. high, the total vertical diameter of the shell at this point being 0·56 mm. or about the same as the lateral. The seventh septum measures 0·47 mm. by 0·23 mm. high; the thirteenth, Plate IX, fig. 7, measures 0·45 mm. broad by 0·28 mm. high. Finally the seventeenth septum, Plate IX, fig. 6, measures 0·50 mm. broad by 0·40 mm. high, showing that the minimum breadth has been passed, and in fact at about the fourteenth septum the breadth seems to be least. It will be noticed that the surface of contact between the inner and outer whorls rapidly diminishes from 0·55 mm. at the first septum to 0·20 mm. at the seventeenth septum, and thence rapidly to the straight portion which begins somewhere between the twentieth and twenty-fifth septa. This surface of contact may be readily traced on the inner whorls of the shell and these traces are indicated in Plate IX, figs. 6, 7 and 8. In the straight portion of the shell the form of cross section passes gradually from a circular to an ovoidal, laterally compressed form and finally in the adult into a somewhat triangular form, acute ventrally (the side on which the siphuncle is located) and flattened dorsally. The cross section of the shell is thus seen to be first lunate, laterally elongated; then successively laterally elliptical, circular, laterally compressed, and finally somewhat triangular. These changes up to the circular form take place very rapidly; the succeeding changes from the circular form to the triangular form are very gradual. In this respect the shell shows very rapid development in the spiral stage and gradual development on quite new lines in the

straight stage. It is also to be noted in this connection that some other species of *Baculites*, as *B. ovatus* Say, *B. anceps* Lam., have a circular or ovate cross section in the adult stage,and probably pass through the same changes as the species under discussion in their earlier stages up to the circular cross section but retain this circular or ovate cross section in the adult.

An examination of the suture lines as represented in Pl. IX, fig. 9, will show quite rapid development here too, but probably not more than is common to all of the Ammonitidæ. As is usual the form of the second suture is entirely different from that of the first. The ventral lobe in the second suture is well marked, the first lateral saddle is here quite broad, the first lateral lobe is acute, and a portion of the second lateral saddle is shown. The ventral lobe of the third suture is a straight line on the end; in the fourth the narrow ventral saddle, which is located over the siphuncle, first appears. The lateral lobes of the third suture are rounded instead of acute as in the second suture and in each succeeding suture the lobes and saddles become more rounded and deeper until they are deeper than broad. During this period of its development the shell may be said to be in the Goniatite stage which persists throughout the spiral shell and as far as about the 30th septum, when the secondary lobes begin to appear at the ends of the lateral saddles and the shell passes into what might be called the Ceratite stage. This Ceratite stage then rapidly gives place to the typical Ammonite stage in which both the lateral lobes and saddles become divided at their ends. Pl. IX, fig. 9, illustrates the development of the suture from the initial to the Goniatite stage. Its development in the Ceratite and Ammonite stages has been illustrated in my former communication on this species already referred to above. The completion of the second lateral lobe and dorsal saddle has probably already taken place on the surface of contact between the protoconch and the first whorl as early as the second suture, though it does not appear on the free surface until the sixth suture has been reached. Owing to the difficulty of handling these exceedingly minute and friable pieces of the shell broken off in displaying the inner whorls and the protoconch no attempt has been made to observe the form of suture on this surface of contact between the inner and outer whorls, but from examining the front view of the septa as they were successively exposed, it was found that the main features of the lobes and saddles first develop on this surface of con-

tact and then appear from the inner side of the whorl on the free outer surface, being exposed by the uncoiling of the shell. The total number of main lobes and saddles of the adult shell is apparently developed at the second septum, and the further development of the suture consists in the formation of secondary lobes and saddles, appearing as complexities of the primary or main ones. Of these secondary folds of the suture, the first to appear is the narrow ventral saddle at the fourth suture, and probably also the narrow dorsal lobe is formed but little later, for both are about equally well marked when the shell passes into the straight form. The fact that the adult number of lobes is developed at the second septum is an evidence of cataplastic development, the adult number of lobes in the suture being usually developed at a much later stage in the normal coiled Ammonites. But in other uncoiled and degenerate forms the næpionic lobes are retained throughout their development and are not added to in the adult stages.

The outer nacreous shell when preserved is found to be marked by minute tuberculations of irregular shape; these in turn give place to the parallel curved lines seen in the adult shell. These parallel lines first appear about the fourteenth septum, and they soon completely obscure the tuberculation. Between the first and second sutures there is apparently an interruption in the growth of the shell, appearing as a line resembling a suture line, Pl. IX, fig. 10. This line seems to be slightly raised above the general shell substance; it extends over the end of the ventral lobe of the second suture and back in a simple curve to near the lateral ends of the first suture. In breaking away the nacreous shell substance to show the sutures, the break nearly always follows this line, leaving the protoconch covered by the original shell. Over the area thus left of the original shell substance the tuberculations are found to be more circular in outline and closer together than in the succeeding portions of the shell. It is believed that the portion of the shell thus bounded represents the original embryonic chamber, or protoconch Pl. IX, fig. 5, which would thus extend beyond the point where the first septum was subsequently developed. A section in the plane of the spiral, but not quite median, Pl. IX, fig. 11, showed the shell to be composed of successively deposited layers, and the first of these was seen to extend a short distance beyond the first septum, thus tending to confirm the above belief. It thus seems probable that the outer limit of the protoconch lies between the first and second

septa, as shown in Pl. IX, fig. 10. The edge of this supposed embryonic shell is seen to be finely crenate, but not regularly so, the crenatures being larger in some parts than in others. On breaking away the outer shell of the protoconch this line still persists and it might readily be mistaken for a suture line, if it did not overlap the lobe of the second suture. The section of the shell in the plane of the spiral above referred to shows that there is no septum at this point, but there is apparently a slight thickening of the shell substance.

The protoconch, as seen in this section in the plane of the spiral, Pl. IX, fig. 11, is quite large and nearly circular, and of the general form common to all of the Ammonoidea. The section not being quite median the siphuncle is not shown, and the septa do not present exactly the same form as they would in a median section. Only one such section was ground on account of scarcity of material to work on, but this one shows the structure to be that of the Ammonoidea in general. The septa were equally spaced, or nearly so, up to the twelfth, from which point they are successively more widely spaced. It is to be noted that at about this point the lateral contraction of the shell ceases and the gradual increase in lateral diameter begins, apparently indicating a change in the conditions of the life of the animal.

After considerable investigation I have been unable as yet to trace the phylogeny of this species. A careful examination of the development of the shell in the earlier stages of *Scaphites conradi* Morton, a form associated with the young of *Baculites* in this same material, showed that the *Scaphites* must have been derived from a totally different stock, and cannot be related to *Baculites*. Nor do the adult suture lines of the two forms show much resemblance to each other. An interesting point was developed, however, in the study of the young of the *Scaphites*, which tends to confirm my observation on the extent of the first embryonic shell as shown in Pl. IX, fig. 5. A very successful median section of *Scaphites conradi* in the plane of the spiral showed a thickening of the shell at the termination of the first layer, which is between the first and second septa as in *Baculites*, this thickening indicating an interruption in the growth of the shell such as might be expected on the emerging of the young from the egg. But this correspondence in the extent of the embryonic shell does not indicate a relation between the two forms, it being a character probably common to all Ammonites. Indeed,

judging from the adult characters alone, this *Baculites* is much more closely related to the forms grouped under the genus *Ancyloceras*, and as far as the young of *Ancyloceras* has been described it seems to be closely related to *Baculites*. On comparing the adult sutures of *B. compressus* with *Ancyloceras jenneyi* Whitf., the similarity is very marked. Lack of suitable material has prevented my examining the young of *Ancyloceras*, but I would suggest that to the genera *Ancyloceras*, *Crioceras*, and related forms with completely separate whorls we are to look for the nearest relatives of *Baculites*. These forms, like *Baculites*, have become uncoiled at a very early stage; their adult sutures are very similar, and the main difference lies in the degree of straightening of the shell. Indeed in *Baculites* the shell is not strictly rectilinear but there is usually a slight curvature towards the dorsal side. While then the relations of this form are still in doubt, it is hoped that the facts presented in this paper may go far towards unravelling the phylogeny of *Baculites*.

EXPLANATION OF PLATE IX.

Fig. 1. Young of *Baculites compressus* Say, x10.
Fig. 2. Protoconch seen from above, x45.
Fig. 3. Protoconch front view, x45.
Fig. 4. Protoconch side view, x45.
Fig. 5. Embryonic shell of first næpionic stage, side view, x45. This is probably the shell possessed by the animal on leaving the egg.
Fig. 6. Front view at the seventeenth septum, showing cross section of the whorl, x25. In this and the two succeeding figures the dotted lines indicate the extent of the surface of contact between this portion of the shell and the succeeding whorl.
Fig. 7. Front view at thirteenth septum, x25.
Fig. 8. Front view at fourth septum, x25.
Fig. 9. The first six suture lines, x35.
Fig. 10. Side view of protoconch and first six septa, showing outline of the first næpionic stage, x40.
Fig. 11. Cross section of shell in the plane of the spiral showing two septa and the imbricated layers of growth, x100.

A NEW SPECIES OF PYCNOGONUM FROM CALIFORNIA.

BY J. E. IVES.

In a collection of Crustaceans and Echinoderms from San Diego, California, recently sent to me for determination by Mr. Frederick Stearns of Detroit, there is an apparently undescribed species of *Pycnogonum*. It is of especial interest owing to the fact that only a single species belonging to the group of the Pantopoda has been described from the Pacific Coast of North America.[1] Although only two species are thus now known from the West Coast it is probable that it will be found in the future that a number of species exist on these shores. Professor Edmund B. Wilson[2] has enumerated fifteen species from the New England waters, and it is possible that as many may be found upon the Pacific Coast.

Five specimens were sent by Mr. Stearns. As none of them possess ovigerous legs I presume they are all females.

The species has been named after the collector. To the liberality of the same gentleman I am indebted for the preparation for publication of the accompanying plate.

The species may be characterized as follows:

Pycnogonum Stearnsi n. sp.

Body broad and flat. Lateral processes with scarcely any interval between them.

Proboscis sub-cylindrical, slightly swollen in its anterior half, but contracting somewhat at its extremity, about one-third the total length of the body.

Each cephalo-thoracic segment with a prominent tubercle dorsally in the median line on the posterior border and a somewhat smaller tubercle on the outer edge of each lateral process; first segment about two-thirds of the length of the proboscis, with a not very broad, slightly constricted neck; second, third and fourth segments respectively equal to about two-thirds of the length of the first; posterior borders of the segments slightly elevated.

Oculiferous tubercle bluntly conical; eyes black, small, nearly equally spaced; the posterior pair slightly further apart than the anterior pair.

[1] *Ammothea longicaudata* Stimpson, from Puget Sound, (Proc. Acad. Nat. Sci. Phila., 1864, p. 159.)

[2] Report U. S. Comm. of Fish and Fisheries, 1878 (1880.)

Abdomen clavate, truncated at its extremity, slightly swollen in the middle.

Legs stout; first or basal joint broad, rather broader antero-posteriorly than the lateral processes of the segments, with the appearance of a dorsal notch on its outer edge due to the close approximation of two dorsal tubercles; second joint rather smaller than the first; third rather smaller than the second; the three joints together in the third ambulatory leg about as long as the proboscis; fourth strongly developed, about two-thirds of the length of the proboscis proximal half of the ventral surface considerably swollen, and a single rather weakly developed dorsal tubercle at its distal extremity; fifth about equal in length to the fourth, but more slender; sixth rather shorter than the fifth; seventh very short, sub-triangular; eighth about as long as the sixth; ninth about two-fifths of the eighth. Fifth, sixth and eighth joints without tubercles; two or three bristles upon the distal dorsal surface of the sixth; a few fine hairs upon the ventral surface of the seventh, and a few bristles upon ventral surface of the eighth. No auxiliary claws.

Color in alcohol, yellowish-brown.

Length of body of the largest of the five specimens, from the extremity of the proboscis to the extremity of the abdomen, 6 mm.

Three of the type specimens have been given by Mr. Stearns to the museum of the Academy and two of them are in his own collection.

This species appears to be mostly nearly allied to *Pycnogonum littorale* Ström, differing from it among other characters, however, markedly in the shape of the proboscis, which in the latter species is conical, and in *Pycnogonum Stearnsi* sub-cylindrical.

A list of the species of *Pycnogonum* hitherto known is appended.[1]

' *P. littorale* Ström.
Coasts of the North Atlantic ocean and adjacent seas.[2]

[1]In this list *Astridium* (*Pycnogonum*) *orientale* Dana, from Balabac Strait (U. S. Expl. Exped., vol. xiii, p. 1391, pl. 96, figs. 2 a, b, c,) has not been included, as it probably represents a distinct genus.

[2]Philippi's (Archiv. f. Naturg., 1843, ix Jahrg. p. 175) record of this species from Naples I consider to be exceedingly doubtful, as Professor Dohrn did not find it there. Philippi probably mistook one of the two species described from that place by Professor Dohrn for this species. I am also very skeptical in regard to the species described under this name from Chili by Nicolet (Gay's Historia fisica y politica de Chili, Zool., T. III, p. 308; Atlas, pl. IV, fig. 8). If a species of *Pycnogonum* is found on the coast of Chili it is almost absolutely certain that it is not *P. littorale*. If the figure given by Nicolet is correct, it must be a species distinct from *P. littorale*.

Var *tenue* Slater (Ann. Mag. Nat. Hist. vol. III, p. 283).
Japan.

P. australe Grube (Jahresb. der schles. Ges. f. vaterl. Cultur, 1869, p. 54.)
Australia.

P. nodulosum Dohrn (Fauna und Flora des Golfes von Neapel, III, pp. 203–207, Taf. XVI, Fig. 1–3, 1881).
Mediterranean (Naples).

P. pusillum Dohrn (Op. cit. pp. 207–210, Taf. XVI. Fig. 4–8).
Mediterranean (Naples.)

P. crassirostre Sars (Den Norske Nordhavs–Expedition, XX, pp. 12–14, 1891.)
Norwegian Coast, Iceland.

EXPLANATION OF PLATE X.

Fig. 1. *Pycnogonum Stearnsi*, n. sp., dorsal surface, much enlarged.
Fig. 2. Right side of the trunk.
Fig. 3. Ventral surface of the trunk.
Fig. 4. Postero-dorsal surface of the third ambulatory leg on the left side, much more enlarged.

BIRDS COLLECTED BY THE WEST GREENLAND EXPEDITION.

BY WITMER STONE.

The collection of birds herein described was obtained June 26 to August 11, 1891, by the West Greenland Expedition under command of Prof. Angelo Heilprin. The specimens were collected by Dr. William E. Hughes, Ornithologist of the Expedition, and Dr. Benjamin Sharp, Zoologist-in-Charge, the principal localities where collecting was carried on being Disco Island, Duck Island (Lat. 73° 57′ N.), Melville Bay, Cape York, and McCormick Bay (Lat. 77° 43′ N.).

Twenty-one species are represented in the Greenland collection which numbers 147 specimens and there are in addition 16 specimens obtained at Sydney, Nova Scotia, Gulf of St. Lawrence and Strait of Belle Isle.

Most of the birds collected were in full breeding plumage and were undoubtedly on their breeding grounds. In the following list I have given the results of careful measurements of all the specimens, and notes in regard to peculiarities of plumage, etc.

1. Cepphus grylle (L). Black Guillemot.

Only one specimen of this bird was procured, a male shot on the Waigat, Disco Island, August 8. The wing measures 6·50 inches and the culmen 1·44 inches.

2. Cepphus mandtii (Licht) Mandt's Guillemot.

Specimens of Mandt's Guillemot were collected in Melville and McCormick Bays and the series obtained shows considerable variation in plumage. One is uniform black while the others are somewhat speckled with white feathers below and have many of the feathers of the interscapular region tipped with white. The white wing coverts in these specimens have distinct black tips and some of them are slightly dusky at the extreme base. These mottled birds are possibly one or two years old and the uniform black garb may not be acquired for several years.

Three nestlings, measuring about six inches in length, are in the collection. They are covered with long and very soft dull black down. The bills have a small white conical projection near the extremity of the upper mandible.

The feet of the adults were bright red in life, while those of the young were black.

Three adult females measure as follows:[1]

Acad. Collec.	Length (in flesh.)	Wing.	Culmen.
No. 26,898	13·18 ins.	6·30 ins.	1·14 ins.
26,899	13·37	6·25	1·16
26,900	13·50	6·32	1·10

3. Uria lomvia (Linn). Brünnich's Murre.

Four immature specimens of this species taken in the Strait of Belle Isle, June 15, measure as follows:

Acad. Collec.	Length (in flesh.)	Wing.	Culmen.
No. 26,887	15·37 ins.	8·25 ins.	1·44 ins.
26,888	16 85	8·00	1·46
26 889	——	8·50	1 47
26 890	——	8·25	1·32

Two adult females in breeding plumage taken in Melville Bay, July 7 and 13 are as follows:

Acad. Collec.	Length (in flesh.)	Wing.	Culmen.
No. 26,891	16·75 ins.	8·35 ins.	1·40 ins.
26,892	15·37	7·90	1·38

4. Alle alle (Linn). Little Auk, Dovekie.

A series of forty-seven Little Auks is contained in the collection, most of which were shot off Cape York, July 22 and 23. The birds are all in full breeding plumage and show scarcely any variations in markings.

Measurements of forty specimens (19 males and 21 females) give the following results:

		Maximum.	Minimum.	Average of series.
Males.	Wing	4·84 ins.	4·35 ins.	4·66 ins.
	Culmen	·66	·55	·59
	Length (in flesh)	9·25	8·36	8·75
Females.	Wing	4·88	4·42	4·67
	Culmen	·61	·52	·56
	Length (in flesh)	9·20	8·25	8·56

5. Stercorarius pomarinus (Temm.) Pomarine Jaeger.

One specimen was shot on the Waigat, Disco, Aug. 7. The measurements are as follows: Wing 13·75 inches. Culmen 1·63 inches. Tail 6 inches.

6. Stercorarius parasiticus (Linn). Parasitic Jaeger.

This species was not noticed by the Expedition, but a dried skin was procured from the natives at Godhaven which seems referable

[1] All measurements of "length" were taken in the flesh by Dr. Hughes, to whom I am indebted for them. The other measurements were made from the dried skins, the length of culmen being from its extreme base to tip of upper mandible unless otherwise stated. All dimensions are in inches and hundredths.

to it. The bill is much heavier than any of the specimens of *S. longicaudus*, the plumage above is decidedly more sooty and the tarsi are entirely uniform in color with the feet. The two species are, however, very difficult to separate owing to the great amount of individual variation which they exhibit.

The specimen of *S. parasiticus* measures as follows: Wing 12·85 inches. Culmen 1·27 inches. Tail 8·05 inches.

7. Stercorarius longicaudus Vieill. Long-tailed Jaeger.

The specimens of Long-tailed Jaegers, all of which were collected July 16 in Melville Bay, show great variation in plumage and no two in the series of seven are exactly alike. All have the tarsi blue-gray strongly contrasted with the black feet, though the light color sometimes terminates above the small hind toe and sometimes extends below it to the upper part of the foot.

No. 26,909, (Acad. Coll.), female, appears to be most typical of the adult bird. The plumage in this specimen is nowhere barred or mottled; the throat and breast are pure white passing gradually into slate gray about the middle of the abdomen, and this color becomes darker on the under tail coverts. On the sides of the breast the gray reaches forward to the shoulders, while the under wing coverts are blackish slate. The back is slate gray, darker on the wings; the primaries and tail are black.

In No. 26,905, female, the gray reaches farther up on the breast and the central tail feathers are not so long.

In No. 26,904, female, (dusky phase ?) the whole lower surface is suffused with sooty gray, though this color is not uniform, as there are a considerable number of white feathers scattered over the breast. The upper surface is mottled with slate-gray and dusky feathers. The under tail coverts and flanks are transversely barred with white but the under wing coverts are plain dark slate.

No. 26,903, female, shows distinct traces of dark transverse bars over the lower breast and abdomen, and has dark shaft lines to the feathers of the throat. Most of the under tail coverts are barred with white and the under wing coverts are barred and mottled.

No. 26,907, male, is similar but has the breast pure white while the barrings on the under wing and tail coverts, sides and flanks are very distinct. The throat is very strongly marked with dusky shaft stripes while many of the feathers of the back show transverse bars of white.

Other specimens are like the mature white-breasted birds but still have the under wing coverts and axillaries barred.

As none of the specimens above described were birds of the year it is reasonable to suppose that it takes at least two years for the species to acquire the full adult plumage. The great variety of coloration exhibited by these Jaegers makes it difficult to arrange them in any order which will show the steps in the transition from young to old. It seems to me most probable that the normal plumage of the bird of one year is shown by No. 26,907, while the young "bird of the year" doubtless shows still more barring, perhaps even on the breast. As this bird approaches the adult stage (i. e. No. 26,909) the barrings are gradually replaced by uniform slate gray.

The specimen No. 26,904 may, I think, represent a partial dusky phase as the suffusion of sooty feathers on the under surface is very decided, much more so than in any of the young birds, with which I at first placed it. The dusky feathers moreover, do not form transverse bands as in the young birds and the under wing coverts are uniform slate colored like those of the adults. The under tail coverts are, however, still barred with white.

If this really represents a dusky phase, it seems to be the first recorded instance of it in this species, though it occurs regularly in the closely related *S. parasiticus*.

If, however, we consider this as a young bird it would indicate that the adult plumage is assumed very differently by different individuals, as there is another specimen which has not a trace of dusky marks on the breast but which has the under wing coverts strongly barred.

The measurements of the specimens are as follows:

Acad. Collec.		Wing.	Culmen.	Tail.
No. 26,905	female	12·35 ins.	1·10 ins.	10·60 ins.
26,903	"	12·20	1·22	11·35
26,902	"	11·80	1·15	8·90
26,904	"	12·30	1·13	7·25
26,906	"	12·45	1·30	10·25
26,909	"	12·10	1·15	12·25
26,907	male	12·25	1·15	9·60

8. Gavia alba (Gunn.) Ivory Gull.

A series of eight males of this beautiful species was collected in Melville Bay, July 6 to 17. Some of the specimens, probably younger birds, have dusky tips to the primary coverts.

The measurements of the series give the following results:

	Maximum.	Minimum.	Average.
Length (in flesh)	20·36 ins.	18·25 ins.	19·36 ins.
Wing	13·40	12·70	13·06
Culmen	1·59	1·40	1·52

9. Rissa tridactyla (Linn). Kittiwake.

Two specimens of Kittiwake were collected July 16, in Melville Bay, Lat. 75° 09′ N. They measured as follows:

Acad. Collec.	Length (in flesh.)	Wing.	Culmen.
No. 26,922	16·75 ins.	12·10 ins.	1·35 ins.
26,923	17·00	11·75	1·39

10. Larus glaucus Brunn. Glaucous Gull.

One specimen shot at Disco Island.

11. Fulmarus glacialis (Linn.) Fulmar.

Eight Fulmars are in the collection, all obtained in Melville Bay, July 7 to 13. Five are in the white phase of plumage and three in the gray phase. They all seem to be typical *F. glacialis*, the measurements being as follows:

Acad. Collec.		Length (in flesh.)	Wing.	Culmen.
No. 26,929	white female	18·00 ins.	12·25 ins.	1·38 ins.
23,932	" "	——	12·70	1·36
26,931	white male	18·62	12·70	1·38
26 930	" "	18·50	12·60	1·40
26.924	" "	19·50	13·10	1·45
26,928	gray female	18·00	12·85	1·32
26,925	gray male	19.25	13·00	1·37
26.926	" "	19·00	13·20	1·44

12. Somateria mollissima borealis Brehm. Greenland Eider.

Five male Eider Ducks and an equal number of females were collected at Duck Island, Lat. 73° 57′ N., July 2. They appear to be referable to *S. mollissima borealis* Brehm, but the measurements of the bill are rather different from those given in Ridgway's Manual. In the key to species on page 109 this race is placed in a division with the true *S. mollissima* headed "Distance from anterior point of loral feathering to extremity of naked angle on side of forehead much greater than from same point to tip of upper mandible." In the present series, however, the reverse is the case or else the two measurements are about equal. As these specimens were taken in the upper part of Baffin Bay, they represent the extreme northwestern form of the *S. mollissima* stock and are farthest removed geographically from typical *S. mollissima*.

It is, therefore, not surprising that they should exhibit the greatest differences from the typical *S. mollissima* and it is probable that

specimens from farther south will be found to approach true *S. mollissima* in the dimensions of the bill as well as in other respects, in proportion as their breeding range approaches that of the latter race.

The measurements of the five breeding males are as follows:

Acad. Collec.	Length (in flesh.)	Wing.	Bill from posterior end of nostril.	Bill from anterior edge of loral feathers.	Naked angle from anterior edge of loral feathers.
No. 26,934	——	11·56 ins.	1·67 ins.	1·50 ins.	1·36 ins.
26,935	23·38 ins.	11·50	1·60	1·46	1·42
26,936	23·50	11·28	1·52	1·50	1·37
26,942	23·62	11·20	1·46	1·48	1·32
26,943	23·62	11·25	1·62	1·55	1·41

13. Somateria spectabilis (Linn.) King Eider.

Three specimens obtained in the vicinity of Disco, June 26 and 28, and August 7.

14. Phalaropus lobatus (Linn.) Northern Phalarope.

Three specimens were procured at Disco Island, June 28 and 29, and Aug. 11.

15. Tringo maritima Brunn. Purple Sandpiper.

One specimen was shot at Duck Island, July 2, and four more at Disco, August 9 to 11.

16. Aegialitis hiaticula (Linn.) Ring Plover.

Specimens were procured at Disco and Godhaven.

Measurements of some of the specimens are as follows:

Acad. Collec.			Wing.	Culmen.
No. 26,960	June 28.	Disco	4·50 ins.	·56 in.
26,958	Aug. 11.	"	4·52	·55
26,954	July 8.	"	5·06	·56
26,955	Aug. 11.	"	4·90	·54

17. Lagopus rupestris reinhardti (Brehm.) Greenland Ptarmigan.

A female and three young nearly full grown were collected at Disco Island, July 8, and two adult males were obtained at the same place, August 7. All the specimens are in the summer plumage though one of the males shows a few white feathers on the upper breast.

18. Falco rusticolus gyrfalco (Linn.) Gyrfalcon.

One specimen obtained from the natives at Disco.

19. Plectrophenax nivalis (Linn.) Snow Bunting.

There is a series of twelve Snow Buntings in the collection, including breeding males and females, moulting specimens, and young in the first plumage. Two young birds were collected at McCormick Bay, July 29, an adult male at Upernavik, July 1 and the rest at Disco, June 28 and 29 and August 11.

The breeding birds show very distinctly the process of moulting by the wearing away of the brown tips of the feathers. All the feathers of the back are very much pointed in the middle and cut away or concave on the sides, all the rusty borders which characterize the winter specimens being worn off. Some specimens, however, show ragged remains of these borders on the coverts and tertials.

Two young birds of the year from McCormick Bay are strongly tinged with buff on the lower back and rump as well as on the under surface, while a young bird from Disco is much grayer.

Adult birds collected August 11 at Disco are all well advanced in their moult and the lower mandible is yellow instead of black as in the breeding bird. The brown edgings to the feathers are rich chocolate, very distinct from the faded buff brown of winter examples from Pennsylvania.

It is interesting to note that all but one of the adult birds collected at Disco, August 11, have the wing and tail feathers completely grown and have about half the other feathers replaced by the brown edged plumage, while birds of the year taken at the same time and place have the wing feathers only partly grown and have not begun to moult elsewhere. This fact may be of interest to students of bird migration as it shows that the old birds were at least ready for the southern journey before the young.

The measurements of the breeding birds are as follows:

Acad. Collec.				Wing.	Culmen
No. 26,978	male	Disco	June 29	4·15 ins.	·51 in
26,980	"	"	" 28	4·20	·49
26,981	"	Upernavik	July 1	4·38	·50
26,979	female	Disco	June 28	4·10	·48
26,977	"	"	" 29	4·02	·48

20. Calcarius lapponicus (Linn.) Lapland Longspur.

A series of eight Longspurs was procured at Disco, June 28 and 29 and August 11. Those collected on the last date had advanced in their moult even farther than the Snow Buntings. The adults were in complete winter garb with the exception of the tail feathers some of which were not quite fully grown.

The bills of the breeding males are bright yellow tipped with black. The measurements of three male specimens procured at Disco, July 28 and 29 are as follows:

Acad. Collec.	Wing.	Culmen.
No. 26,970	3·75 ins.	·51 in.
26,971	3·70	·51
26,972	3·78	·51

21. Saxicola oenanthe (Linn.) Wheatear.

One male bird procured at Disco, Aug. 11, has just completed its moult. The wing measures 4·18 inches and the culmen ·53.

The species obtained before the expedition reached Greenland were as follows:

At Sydney, Nova Scotia, *Empidonax flaviventris* Baird., *Corvus americanus* Aud., *Ammodramus sandwichensis savanna* (Wils.), *Melospiza fasciata* (Gm.), *Melospiza georgiana* (Lath.), *Chelidon erythrogaster* (Bodd.), *Setophaga ruticilla* (Linn) and *Merula migratoria* (Linn).

In the Gulf of St. Lawrence the following species came on board the vessel: *Pinicola enucleator* (Linn), and *Dendroica virens* (Gm.).

There were also several specimens of *Uria lomvia* (Linn.), secured in the Strait of Belle Isle.

MARCH 1.

Rev. H. C. McCOOK, D. D., Vice-President, in the chair.

Twenty-five persons present.

The death of Wm. H. Dougherty, a member, March 1, 1892, was announced.

MARCH 8.

The President, General ISAAC J. WISTAR, in the chair.

Thirty-five persons present.

A New Species of Pachychilus.—MR. H. A. PILSBRY exhibited and described a species of fresh-water snail, as follows:

PACHYCHILUS (POLYGONATUS Lea? var.) ROVIROSAI.

Shell large and heavy, elevated conical, the lateral outlines straight above, modified by the slight convexity of the whorls below. Spire more or less truncated at tip, half-grown specimens, Pl. VIII, fig. 9, possessing 8 remaining whorls; adults, Pl. VIII, fig. 10, having one or two whorls less.

Surface most minutely spirally striated, the striæ visible only under a lens. Young and half-grown specimens are otherwise smooth, except for very slight spiral liræ toward the base. When a little more than half-grown, there appear coarse, oblique, curved wave-like folds on the body-whorl, extending to the periphery but not below it. Simultaneously with these undulations, begin spiral spaced liræ crossing them, which are slightly more prominent on the crests of the waves. This sculpture continues upon all subsequent volutions. The last volution of an adult specimen is slightly compressed below the suture, then quite convex. It has ten waves, and about nine spiral liræ, but the number of these last is quite variable on different specimens.

The color is olive in young, blackish in old examples; interior of the mouth white, maculated with brown at the position of the periphery and folds. This marking is also seen on the eroded spire in some specimens.

Aperture ovate, acute above, slightly exceeding one-third the total length of the shell. Columella white, regularly arcuate, spreading in a brown-tinted callus.

Dimensions. An adult specimen measures: Alt. 78, diam. 28 mm. Aperture, alt. 25, width 18 mm. A younger specimen measures: Alt. 55, diam. 20 mm. Aperture, alt. 20, diam. 12½ mm.

Collected from a spring which gushes from the western brow of the little ridge of the Limon, State of Tabasco, Mexico, by Prof. José N. Rovirosa.

This seems to be a very distinct species when compared with the typical forms of the described Mexican Pachychili; but these, like all Melanians, are so variable that it is scarcely desirable to multiply species until fuller collections are made. It is here associated with Lea's *Melania polygonata* because that species is the first described of the particular group of forms to which the present species or variety belongs.

MARCH 15.

The President, General ISAAC J. WISTAR, in the chair.

Thirty-three persons present.

A paper entitled "Greenland Lepidoptera," by Henry Skinner, M. D., was presented for publication.

The death of DR. SERENO WATSON, a correspondent, March 9, aged sixty-six years having been announced, the following preamble and resolutions received from the Botanical Section, were adopted:—

Whereas—The Botanical Section of the Academy of Natural Sciences of Philadelphia having learned with profound regret the death of Dr. Sereno Watson of Cambridge, Mass., and being desirous of placing on record its sense of this great loss to Botanical Science throughout the world:—

Resolved—That we recognize the invaluable results of his work in the dissemination of a knowledge of American Botany to which he has given his undivided attention for many years, and which has made his name famous wherever the study of plant life is cultivated.

Resolved—That a copy of this minute be forwarded to the President of Harvard University and to the Gray Herbarium at Cambridge with which he was so long associated, and that the same be offered for publication in the Proceedings of the Academy.

MARCH 22.

The President, General ISAAC J. WISTAR, in the chair.

Thirty-eight persons present.

The deaths of the following members were announced:—

Thomas Hockley, March 12, John McLaughlin, March 17, and Andrew J. Parker, M. D., March 18.

MARCH 29.

The President, General ISAAC J. WISTAR, in the chair.

Forty-four persons present.

A paper entitled "On the Anatomy of Sagda, Cysticopsis, Ægista and Dentellaria," by Henry A. Pilsbry, was presented for publication.

The following were elected members:—

General John Markoe, H. G. Bryant, Frank Woodbury, M. D., Daniel Allen Knight, Jr., Thomas Wistar, M. D., Miss Lucy Langdon Williams and Miss Jean Fraley Hallowell.

Prof. Carl Claus of Vienna and Frederick Stearns of Detroit, Mich., were elected correspondents.

The following were ordered to be printed:—

GREENLAND LEPIDOPTERA.

BY HENRY SKINNER, M. D. AND LEVI W. MENGEL.

Four hundred and forty-four insects were taken by the expedition sent to Greenland by the Academy in the summer of 1891. They were divided among the different orders as follows: Hymenoptera 25 specimens, Coleoptera 4 specimens, Lepidoptera Rhopalocera 143 specimens and Heterocera 143. They were captured by Levi W. Mengel, entomologist to the expedition and Dr. W. E. Hughes, ornithologist. The specimens are all from the West Coast and were taken at three principal localities: McCormick Bay, Herbert Island and Disco.

RHOPALOCERA.

PIERIDÆ.

Colias hecla Lef.

Fairly common, although few of the specimens were quite perfect. Both sexes were represented. There was one beautiful specimen of the white form of the female, which seems to occur in most if not all the species in the genus. Mr. T. D. A. Cockerell has suggested that all these forms of the female in the different species be called *pallida*, and we think the suggestion a good one. *Hecla*, when at rest on the herbage with its wings over its back and its green undersides showing, is said to mimic its surroundings in a remarkable manner. This Greenland *hecla* is what Mr. M'Lachlan called var. *glacialis*, to distinguish it from the Lapland form and those found further south.[1]

Colias hecla pallida n. var. ♀ Ent. News, Vol. 3, No. 3, pl. 2, fig. 4.

Expands 40 mm. Upper side: Superiors are the same in maculation as in the yellow or normal female, with the exception that there are but two very minute cream-colored dashes on the wide, black marginal border. The inner two-thirds of the wing is cream color with a pinkish tint, obscured by gray near the base. Inferiors with same maculation as normal female but in color totally different. The spot at the outer end of cell is cream color, and the base of the wing is a steel gray; from this outward to the black marginal border is dark olive-green obscured with gray. Inside of the mar-

[1] Proc. Linn. Soc. Lond. Vol. 14, p. 108.

ginal border the row of spots is obscure cream color. Fringes of all the wings milk white. Undersides: Superiors nearly the same color and maculation as above but with a yellow tinge. Inferiors light olive-green dusted with gray. This is very different from the rich grass-green underside of the normal form. The spot in the cell has less red around it and is more silvery than in the yellow female. It would more properly be called the dimorphic white female form and is probably the prettiest form of American *Colias*.

Lycæna aquilio Boisd.

Three specimens.

NYMPHALIDÆ.

Argynnis chariclea Schneid.

Quite abundant and many of them in good condition. Among them were a few specimens of what Mr. M'Lachlan called var. *obscurata* (Proc. Linn. Soc. Vol. 14, p. 109). This form was figured in Ent. News, Vol. 3, pt. 3, pl. 2, figs. 9, 10. Mr. M'Lachlan, in the paper above referred to, says: "Under this head (*chariclea*) I feel compelled to group 20 examples. Never before have I been so perplexed over a series of an insect of which I had made a serious study. I may safely say that no two of the twenty individuals are precisely alike. It would be utterly useless to attempt to describe the forms; the only thing that could be of service would be to give colored figures of both sides of nearly every example." If we had had a few specimens representing the extremes of variation in this species we would probably have described two or three new species, but having a good series with all the mutations represented we can only conscientiously call them *A. chariclea*. This is a case where breeding a large number from the eggs of several known females would solve the problem so far as the examples of a given area are concerned, but we think some entomologists attach too much importance to this kind of proof in other directions. A thousand specimens of the Greenland form of *A. chariclea* might be bred without finding one that agreed with the European form; yet this would be no proof of their being valid species if all their geographical intergrades could be found. This species was stated by Doctor Hughes to also mimic its surroundings, as, unlike *C. hecla*, it rarely alighted on the herbage but on the ground and rocks which it more nearly resembles in color.

HETEROCERA.

BOMBYCIDÆ.

Dasychira Grœnlandica Wocke, Zweite Deutsche Nordpolarfahrt, Bd. 2, Abth. I, p. 409. Ent. News Vol. 3, No. 3, pl. 2, figs. 1, 2, 3.

This species was described in 1874 and so far as we know has never appeared in any of our American lists. An allied species, *Dasychira Rossii*, has improperly been placed in the genus *Laria*. *D. Grœnlandica* is of a smoky black subdiaphanous color with strongly marked black neuration of the superiors. The female is a heavy-bodied insect and in our one specimen devoid of marking. There were two males which differ considerably but undoubtedly belong to the same species. *D. Rossii* has a black border to the wings entirely wanting in *Grœnlandica*.

NOCTUIDÆ.

Plusia parilis Hubner.

There were two specimens of this rare and strongly marked species.

Anarta Richardsoni Curtis.

Several specimens of both sexes; a very variable species.

Anarta Zetterstedi Staudinger.

A number of specimens that present a great amount of variation, some being a rich velvety black with the white lines strongly brought out and others faintly marked. These presented as great difficulties as the specimens of *Argynnis*, no two being exactly alike and we have no doubt some entomologists would make a number of species out of them, but there are no missing links in the gradations.

Anarta Besla n. sp.

Expands 21 mm. Upperside: Superiors gray with a yellow luster, immaculate; fringes gray. Inferiors same as superiors except that the fringes are white. Underside similar to the upper except that there are indications of a white band crossing the center of both wings from the costa of the superiors to the lower margin of superiors and there is a faint lunate spot in the middle of the inferior and one above the center of the superior. Thorax, abdomen, head, etc., above and below, of a dark gray, almost black. This comes near *A. Zetterstedi* and may be an extreme form of it.

GEOMETRIDÆ.

Glaucopteryx polata Hubn.

Glaucopteryx Sabinii Curt.

Glaucopteryx immaculata n. sp.

Expands 22 mm. Upperside: Superiors shining silky gray; immaculate. Inferiors immaculate and several shades lighter in color than the superiors. Underside of all wings of a uniform gray of about the same shade as the upperside of inferiors. Antennæ pectinated. The remaining portion of the insect is black or very dark gray. Mr. M'Lachlan refers to this as a form of *G. Sabinii*, but even if it proves to be such, it deserves a name as all varieties do when one cannot say at once, on inspection, what the species is. The most noticeable fact about the Greenland Lepidoptera is their great variability, which is probably owing to the short season in which they live, and perhaps also to their uncertain appearance, due, perhaps, to sudden changes of temperature while they are in the larval or chrysalis condition.

CONTRIBUTIONS TO THE LIFE-HISTORIES OF PLANTS, NO 7.

BY THOMAS MEEHAN.

On the Vitality of some Annual Plants.

Prof. Theo. Holm, of the Smithsonian Institution, is the author of a suggestive paper under this title.[1] He notes a number of species generally recognized as annual which frequently furnish biennial or perennial individuals. Such observations are especially useful, for it is deviation from general rule that furnishes us with keys to unlock the great treasure-box of nature's secrets. If we can show that annuals are not always annuals, but sometimes become perennials, we have the opportunity to watch the process, and learn as the work goes on.

Horticulturists must have long known, without giving the matter serious thought, that annuals become perennials under some circumstances. Petunias, Gaillardias, and indeed I can think of no annual plant of any kind whatever, that the horticulturist cares to preserve, that he can not preserve from cuttings when he so desires. Even in the case of those annuals which throw up only a single flower scape, he plucks off the flower head before the flower buds expand, cuts up this flower stem into sections, and raises plants which will live continuously for many years, if annually treated in the same way. Annuals or biennials will live for many years if the flower buds are plucked out as soon as they appear. The author of this paper has seen mignonette six years old that had been treated in this manner. Annual parts of perennial plants also live over when propagated in the same way. Perennial phlox, hollyhock and similar plants are raised from sections of the flower stems which have had their flower heads taken out a few weeks before they were cut into the segments desired.

It is worthy of remark just here, that few plants except those which we distinctly recognize as ligneous, have perennial parts. The potato lives only through the tubers it makes annually, and even the strawberry plant will be found to be dead below the addition of the past year. Gladiolus, lilies, many terrestrial orchids, and numerous other plants, only live over through the additions of the preceding year. The older portions die after new portions have

[1] American Journal of Science, Vol. XLII, Oct., 1891.

been formed. In brief, the power to produce offshoots or stolons is really the only difference between the annual or perennial herbaceous plant.

It may now be further noted that, morphologically, there is no difference between a stolon and a flower scape,—a rhizome or a permanent flower stem. The strawberry is one of the best illustrations of this. The "Bush Alpine" never makes a "runner"—all that would be stolons becoming erect flower scapes. The transitions between flower scapes and stolons may be seen at any time by the careful observer. But the flower scape is an annual, while the stolons remain over until another season.

We may now consider the causes inducing the annual or the more enduring conditions. It is now well understood that though the reproductive condition of a plant is a natural outgrowth of the vegetative, there is a certain antagonism between them. The husbandman must root—prune, or take off a ring of bark, or practise some such severe measure, before an extra vigorous tree can be made productive. On the other hand even sound trees have been led to death's door by overbearing. Annuals die from no other cause than by the heavy draft on vital power through bearing seed so early and profusely, with nothing but a single root-stock to provide nutrition for the whole.

Professor Holm, though he is not clear whether it is climate, soil, cultivation or other cause, which leads the annual occasionally into the perennial class, quotes Lange as showing that *Carex cyperoides*, under normal conditions truly annual, is "able to vegetate several years when it happens to live without flowering." Several years ago I had a number of plants of the caraway, *Carum Carui*, transplanted after they had commenced to push up flower stalks. As the flower stalks withered, they were plucked out to the base. All the plants became bushy perennials! Profiting by the hint I have some plants, with the stems annually plucked out, that are now four years old.

Going back to the strawberry, why does the scape die the same season, and the stolons endure? Is it not that the stolons, sending out roots at the end which form leaves instead of flowers, are under more favorable conditions of nutrition? The scape is drawing heavily on vitality which the unfavorable conditions of nutrition do little to sustain.

I have little doubt but that any annual may be made perennial by persistently destroying the flower buds as they appear. When we see in a state of nature, some few plants survive while numbers perish the season of their birth we may reasonably look for some circumstances which in these plants led them to bear seeds less profusely than others, or to some other condition which aided the vegetative in its struggle with the reproductive forces.

On Self-pollination in Amsonia Tabernæmontana.

To my mind the number of plants which have their flowers constructed for self-fertilization is so large, that it would seem hardly worth particularizing them but for the industrious work of noting the opposite characteristics which prevails in our scientific serials. It seems not fair to true science that only one side of nature's story should be told. This is why I record some self-fertilizing cases.

It has been left to me to point out that only those plants which have other means of persistence than by seeds, have flowers which are wholly dependent on external agents for pollination,—and also to show that while flowers which have arrangements for self-fertilization are abundantly fertile, those which cannot make use of pollen without assistance, are frequently barren, and are at a sad disadvantage in making their way through the world. So clearly has this been worked out to my mind, that when a plant is found abundantly fertile, it is fair to assume that it must be arranged for self-pollination. In *Asclepiadaceæ*, with the large majority of the flowers barren, we may theoretically assume insect agency,—with many abundantly fertile *Apocynaceæ*, we may assume self-fertilization.

I have already shown than the Madagascar periwinkle, *Vinca rosea*, with every flower fertile in American gardens, is a self-fertilizer. Another of the same order, *Amsonia Tabernæmontana*, (the form known as *A. salicifolia* Pursh), is abundantly fertile. I watched the flowers this season, satisfied that they would be found arranged for self-pollination. The plants proved, as usual, abundantly fertile. On one panicle there were twenty-nine pairs of follicles that matured; there were many others that had been evidently fertilized, but failed to reach maturity through lack of nutrition.

Showy as the blue flowers are, and we might suppose in view of prevailing speculations, made so in order to be attractive to insects, the arrangements are such that no insect, not even the ubiquitous

thrips can gain entrance to the nectary. The mouth of the tube is so densely matted with hair, that *Faux clausa* is the term used in the description of the species by Latin authors. If a pollen-clothed tongue were thrust through the mass, it would be thoroughly cleaned, and in like manner the flower's own pollen would be brushed back, when the insect withdrew its tongue. But a greater difficulty presents itself. The capitate stigma with its surrounding rim, completely fills the upper portion of the tube. There is no space for an insect's tongue to get past the stigma. But even could this rubicon be passed, a dense mass of hair presses close against the style, and the most powerful insect known to the writer, could hardly force a passage. The entrance of insects is completely blocked. To provide for pollination, the anthers curve over and rest on the stigma, and the pollen on ejection from the anthers, can do no more than cover the stigma with their own pollen.

In many plants which have flowers that are generally fertilized by their own pollen, the arrangements will often permit of pollination from some other; but in the case of this *Amsonia*, nothing but self-pollination is possible.

To those who may not have flowers for comparison, the figure of this plant in "Botanical Register," Plate 151, will aid in making some of the above noted points clear.

On a special form of Cleistogamy in Polygonum acre.

In a paper published in the Proceedings of the Academy (1889, p. 59,) I pointed out that in almost all—probably in all cases, the fertile flowers were pollinized in the bud in all the species of *Polygonum* that I had had the opportunity of examining: that they were really cleistogamous. There are two classes of flowers in the inflorescence. Many expand and are to all appearance hermaphrodite, with all their sexual organs perfect, but infertile; another class never opens, but are invariably fertile.

In May, 1890, I noticed a quantity of *P. acre* in a swamp in Chester County, Pennsylvania, with a short and close habit. The leaves were shorter and broader, and the ochrea shallower than usual. Small white flowers were protruding above the sheaths, and I suspected I had found a new species in the section with axillary flowers. But on examining *P. acre* in other localities, I found, in every case, flowers hidden under the ochrea from even the lowest axil on the branch. It was the shallowness of the ochrea

in the form I found, exposing the flowers, that led to the discovery. Since then I have examined herbarium specimens from a very wide range of territory, and find these hidden flowers always with this species, and in many cases giving such a gland-like character to the base of the ochrea that it is inconceivable how the production of these flowers should have been overlooked so long. I gathered some specimens in the streets of Washington, and showed them to the members of the American Association in attendance there; and Mr. T. H. Kearney, Jr., of the University of Tennessee, has since confirmed the discovery by a note in the November issue of the Botanical Gazette. He found them in Knoxville, Tenn., as late as Sept. 24th. His excellent drawing, accompanying his note, shows the cleistogene flowers are much closer down among the roots than I found them. Mr. Kearney could find them in no other species, nor have I been able to do so. A close examination of many in the large herbarium of the Academy, gave no indications of this tendency in any other species. As already noted there seems no fertile flowers in any *Polygonum*, except from cleistogene flowers at the apex of the branches. This species has them specially in the axils as well as in the terminal spikes.

In examining a large number of specimens in herbaria in connection with this question, it is interesting to note how often *P. acre* is confounded with *P. Hydropiper*. For all the differences noted in our botanies, I think they are more closely related than supposed. I once thought I could easily decide the differences by the seeds, but I have not unfrequently found flattish seeds in *P. acre*, that could not be distinguished from the usual flattish seeds of *P. Hydropiper*. In forms, however, that we would certainly refer to the latter species, no tendency to the axillary cleistogamous flowers can be detected.

On the direction of growth in Cryptogamic Plants.

No one has yet been able to present an explanation of the direction of growth in flowering plants, that will stand the test of criticism. Growth has a general upward tendency, though in the same tree we have varying directions. Many *Coniferæ* have one perfectly vertical central stem or leader, while the side branches may be wholly horizontal, or at various angles uniform in each species. Occasionally individuals will vary from the normal line of direction, and present angles wholly different from that prevailing

in the accepted characteristic of the species. Then we have the so-called fastigiate varieties, as in the Lombardy Poplar,—or in trees with pendulous branches, as in many trees of gardens known as weeping forms.

To say that branches are geotropic or heliotropic does not teach us anything, they only repeat the actual fact; nor do any of the terms commonly used in mathematical or physical explanations of the supposed cause.

Some observations I have made in connection with mushrooms are worthy of recording. They do nothing to elucidate the mystery, but they gain for us the certainty that many partially accepted conclusions are wrong, and it is always an advantage to be able to limit the circle in which we have to search.

I found a quantity of edible mushrooms growing on the sides of a newly made terrace the face of which had an angle of about 34°. The stipes of the mushrooms pushed out at an exact right angle with the plane of the slope; but about midway the stipe bent upwards, so that the pileus or crown of the mushroom, instead of being parallel to the slope of the bank had, in a great measure, become horizontal. As the growth of the mushroom is mainly or only at night, light could have had no influence in determining this direction of stipe or pileus,—nor, it will surely be conceded, could anything connected with gravitation or the attraction of the earth.

Recently, in a coal mine in Schuylkill County, Pennsylvania, at some 500 feet beneath the surface, I noted that the same species of *Polyporus*, *Agaricus*, and other fungi, that grow from the trunks of dead trees, were here also on the wooden supports of the gangways. The *Agaricus* pushed the pileus downward or upward just as the point of growth was above or beneath a log. Just when the pileus was about to expand and separate from the stipe, which was not until the stipe had reached its full length, the latter would curve so that the pileus would be brought into a perfectly horizontal position, as if the agaric were growing on a piece of level ground. No special law governed the direction of the stipe. They might grow horizontally for several inches from an upright log, vertically from the upper side, or downward from the lower side of a horizontal log. When the time came for the expansion of the cap, the already grown stipe would depart from the straight line, and curve so that the cap would occupy the horizontal position as we see them above ground. If the cap were to fully expand, or to be in any rapid

state of expansion when the curvature of the stipe began, we might conjecture that it was some action of the pileus or cap that caused the stipe's curvature, but it was evident that the departure from the straight line, was nearly or quite simultaneous with the rupture of the hymen, and that nothing connected with any external circumstances influencing the expansion of the pileus had anything to do with the matter.

When we consider the facts as relating to these cryptogams, and the facts in connection with the various angles in the branching of the same species among flowering trees it seems to be a fair inference that the law which determines the direction of growth has very little, if any, relation to conditions of environment. If the mystery is ever solved, it will probably be found among the properties of the single cell, from which the whole characteristic of the plant is finally developed.

Tricarpellary Umbellifers.

Dr. Lindley observes ("Vegetable Kingdom", p. 774) "in some accidental cases three carpels have been found" in Umbellifers. In these days when the genesis of families is an active study, departures from usual characters are of more value than when Lindley wrote. It is these variations that frequently give the clue to family relationships. It is worth recording that in *Eryngium planum* Linn., a species from the north of Europe and Asia, trigynous flowers occur with some frequency. I rarely examine a head without finding one such flower, and I have found six in one head. There is usually one near the largest and longest involucral bract, and they are generally found in the lower part of the head, in the vicinity of the bracts.

A plurality in the number of carpels is one of the characters relied on to distinguish *Araliaceæ* from Umbellifers. The trigynous flowers of this, and probably other Eryngiums show a line of relationship between the two families.

The facts may also suggest a not distant relationship with *Valerianaceæ*.

A mode of variation in Stellaria media.

Among a number of well developed plants of the common chickweed growing on a compost heap, it was interesting to note that no two seemed to be exactly alike. They differed from one another

in almost every respect, some in form of leaf or flower, others in manner of growth or general habit. One very vigorous grower, with a loose rambling habit, was compared with one of compact formal growth. The leaves and general characteristics of each were precisely the same; but in one the internodes were eight inches, while in the compact form they were but four. The whole difference in appearance was dependent on this single circumstance.

On the Sexes of the Holly.

In Martyn's edition of Miller's "Gardener's Dictionary," published in 1807, much stress is laid on the fact that the English holly, *Ilex Aquifolium*, is dicœcious. Philip Miller say it was discovered first by his father. It was considered a very important discovery as removing *Ilex* from the class *Tetrandria*, where Linnæus placed it, and giving it place in *Polygamia diœcia*. In those days botanical facts of this character had bearing on few other questions than that of classification. It is not surprising, therefore, that authors since Martyn's time have hardly thought the matter worthy of any consideration. The most critical of all English botanists, Dr. Arnold Bromfield, in his "Flora Vectensis," giving nearly two pages of close print to a minute description of every character, passes over the question of sex by observing; "the earlier flowers are said to be generally imperfect, and such as are 4-cleft to generally want the germen, which accounts for the small quantity of berries produced by some trees which flower abundantly."

In these days when the laws which influence the production of sexes in flowers, and the various questions arising from dimorphism and the relation of insects to fertilization have become matters of paramount importance, the actual condition of the sexual character in the holly is a matter of considerable interest, deserving much more critical attention than has been given it.

The description given by English authorities fits exactly the characters of the male flowers of *Ilex opaca*. I venture, therefore, to express an opinion that the *Ilex Aquifolium* is dicœcious like its American relative. I am inclined to believe, however, that the dicœcism of closely related species is much more pronounced in the American than in European forms. This would have an important bearing on evolutionary studies. It would be worth while for observers in the old world to note whether any separate plant of *Ilex Aquifolium* has truly hermaphrodite flowers, or even perfect

fruit, on plants which seem to have only male flowers. Supposing the English holly to have the same characters as the American, the female flower, solitary on the pedicel, will easily be distinguished from the bi- or tri-florous staminate ones.

Twenty *Ilex opaca* trees on my grounds were carefully examined on May 30th. Eight of these are purely pistillate plants. The gynæcium is large and perfectly developed in every respect, and although there were apparently four stamens, they were membranous and functionless. The pistillate flowers were easily recognized by being solitary on stout pedicels. There were but four or five flowers on each branch, and one might almost pass a tree without knowing it was in bloom, unless the flowers were sought for. The male flowers on the other hand were bi- or tri-florous, and often two common peduncles arose from the same axis. The stamens were large and the anthers abundantly polliniferous, the ground beneath the trees being thickly strewn with the fallen blossoms. The gynæcium remains at the base of the flower in a wholly undeveloped condition. By these characters one can tell at once, without any critical examination, the fertile from the infertile tree. It is not improbable that there are some trees that may produce male and female flowers on the same tree—may be monœcious,—but these twenty trees, thoroughly diœcious, would indicate this to be its prevailing characteristic.

A slight jarring of a branch indicates that the female tree may have their flowers pollinated by the agency of the wind. Honey bees were, however, busily collecting nectar indifferently from the flowers of both sexes, and may aid in pollination.

On the Stamens of Ranunculus abortivus.

Of all plants we should hardly expect to find definite stamens in *Ranunculus;* but in *R. abortivus* I find them uniformly in three series of five each, 15 in all. The first five mature contemporaneously with the opening of the flower, and the large full anthers of this series set, as they should be, alternately with the petals, contrast so greatly with the undeveloped ones, that our first impression might be that we were examining a five-stamened flower. In *Ranunculus bulbosus*, blooming among these plants, no such striking difference could be noted. If other species have this peculiarity it might be useful as a sectional character.

My object in examining the flowers closely was to note their habit in relation to pollination. As every flower, and we might say every

carpel, is fertile, we may look for arrangements to insure self-fertilization. But the anthers do not seem to mature before the expansion of the petals, and do not appear to be well situated to pollinate the stigmas. The flowers have no odor to attract insects, nor do I find after many attempts to discover them, that any insects visit the flowers. The flower stems droop at night-fall, and I have, heretofore, thought that, in the act of drooping, pollen falls from the anthers to the stigmas; and I meet with no suggestions warranting a modification of this belief.

On the character of the Stamens in Ornithogalum umbellatum.

It need scarcely be noted that the floral whorls of Liliaceous plants are in sets of three, though it is often difficult in the six-leaved perianth to distinguish the three-petaled from the three-sepaled series.

In *Ornithogalum umbellatum* each three are well defined on the outer and the inner whorl, though there is no difference between the two except in the smaller size. The filaments are petaloid, and the outer whorl of three follows the character of the petals in being of a still smaller size. But when we come to the fourth series, or interior set of three stamens, they are found to be larger in their filaments than the three before them.

It is so unusual to find an inner series of stamens more petaloid than the outer, that the fact is certainly worth recording.

Few of this genus are odoriferous: this is one of the exceptions.

Note on Barbarea in connection with Dichogamy.

So far as I am aware no botanist but myself has ventured to explain the cause of dichogamy. I have shown that stamens are called into active growth under a much lower temperature or a less enduring warm temperature than pistils. Hence a flower which may be proterogynous under a continuously warm period late in spring would be proterandrous under the fitful advent of a few warm days in other seasons.

I have long ago called attention to the fact that the *Barbarea vulgaris* is proterogynous while *Barbarea præcox* is proterandrous. At that time I had no clue to the reason for this great difference between two species so closely allied that botanists have usually to wait until the fruit is nearly mature before they can positively distinguish them.

Both species grow in abundance on my ground and I have good opportunity to observe them. *B. vulgaris* is confined to the low ground and *B. præcox* to the high dry ground among cultivated plants. It may be found out of cultivated ground or on waste places of much the same character as on the former, but I have never seen it in the thoroughly native condition of *B. vulgaris*.

B. vulgaris comes into bloom regularly about the first week in May with little regard to whether February or March is fitfully warm, or of a continuously temperate character. *B. præcox*, on the other hand, is so easily excited that while in some seasons it will be in flower cotemporaneously with the other species, in others it is nearly over before the *B. vulgaris* commences to bloom. Habituated to localities favoring such varying conditions of temperature, it would certainly acquire the proterandrous character, while the other species under more retardative conditions would become proterogynous. A habit once formed will, we know, continue in plants as well as in animals, by inheritance, long after the causes that induced it have ceased to operate. It is, therefore, quite likely that though *B. præcox* were to find itself growing beside *B. vulgaris* in the low and continuously cool atmosphere of a wet meadow, it would still show for a time much of the proterandrous character it had formed through its earlier associations with other conditions.

Though I regard environment as having much less to do with the formation of what we must regard as permanent specific characters than is often claimed for it, it is generally conceded to be a great factor in permanent change. The facts here noted certainly indicate its influence in producing dichogamy which would undoubtedly become a fixed character in many instances.

An extremely interesting point in the close study of the two species is that the proterandrous species is evidently so arranged that cross-fertilization is well nigh impossible. On the other hand the proterogynous species seems incapable of using its own pollen until it has had every chance to receive pollen from other flowers. In the latter case the pistil pushes its way through the unopened perianth, exposing the pin-head form of the capitate stigma. The plants on my ground are in great favor with honey bees, which seem scarcely to care to visit any other flowers when *Barbarea vulgaris* is abundant, and the exposed stigmas can scarcely avoid

being freely dusted with foreign pollen by these industrious creatures.

On the other hand the stigma is much below the anthers at the time the flower expands in *B. præcox*. The pollen is discharged before the flower opens, and when the stigma is brought up through the stamens by the elongation of the ovarium, it is found to be dusted by its own pollen. In this species the flower is surely a self-fertilizer.

It certainly must be interesting to the biologist to note two species so closely related, possessing such diametrically opposite conditions as regards the fertilization of their flowers; and the teleologist cannot fail to be equally interested, as the facts have an intimate bearing on the questions he has to discuss. To my mind the chief value of the facts related lies in the additional proof they afford that dichogamy, to a great extent, is dependent on the varying conditions that excite advanced growth in stamens or pistils respectively.

It may be added in connection with the subject of the free visit of honey bees to these flowers, that the flowers have no odor perceptible to our senses.

APRIL 5.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Fifty-three persons present.

APRIL 12.

The President, General ISAAC J. WISTAR, in the chair.

Forty-five persons present.

APRIL 19.

The President, General ISAAC J. WISTAR, in the chair.

Thirty-one persons present.

APRIL 26.

The President, General ISAAC J. WISTAR, in the chair.

Sixty-five persons present.

A paper entitled "On the Mechanical Genesis of the Scales of Fishes," by John A. Ryder, was presented for publication.

Prof. F. H. Giddings was elected a member.

On the Molars of the Pteropine Bats.—DR. HARRISON ALLEN called attention to the homologies of the cusps of the molars in the pteropine bats. In *Pteropus medius* the grinding surface of the parallelogram-like crown of the first upper molar is traversed its entire length by a groove which is bounded externally by a thick ridge and internally by a narrow ridge. The outer ridge forms an imperfectly developed cusp at its anterior part which is probably the paracone. The inner ridge is imperfectly divided into two subequal parts, of which the anterior is probably the protocone and the posterior the metacone, the heel (hypocone) being absent. These identifications agree with the cusps as seen in other mammals. Owing to the great size of the grinding surface it becomes difficult to understand why the backward extension of the tooth differs from other types in the form of the primary cusps instead of the evolution occurring as is the rule by the appearance of the hypocone.

The commissure which constitutes the anterior and the posterior borders of the tooth are exceptionally well defined and the one last

named appears to take the place by adaptation of the region of the hypocone.

A recent observation on *Cephalotes* has suggested to the recorder that it is probable that the hypocone is really present and that the greater part of the grinding surface may be so named. In this genus the parts protocone, paracone and metacone can be easily discerned. The protocone according to this identification compels one to accept the cusp named as protocone as in truth the metacone, and thus the usual elements of a tritubercular tooth are all accounted for, and the remaining extended part of the tooth becomes the hypocone.

By this identification the pteropine molar ceases to be aberrant. But it must be remembered that the process of reduction of the face which takes place in the pteropines is likely to be accompanied with the same disposition to tooth variation as is seen in the Stenoderms among the *Phyllostomidæ*. In this family the molar teeth are highly aberrant and the commissures at the anterior and posterior borders greatly developed. The question naturally arises why may not the molar in *Cephalotes* be acknowledged to be also aberrant and the cusp named above the protocone be in reality nothing but a supplemental cusp projected from the anterior commissure and the parts as defined for the long faced *Pteropus* be true for all genera? On the whole Dr. Allen inclined to the opinion that the statement first made was the correct one since it permitted the cusps to be named with the least amount of violence to accepted views.

The first molar in both *Cephalotes* and the related *Harpyia* closely resembles the last premolar, so closely indeed as to suggest that it may prove to be one of the premolar series. But our knowledge of the milk dentition does not permit this identification to be made with certainty. The transition in all the details is certainly much more gradual than is usually the case between a molar and a premolar. In *Harpyia* at least the first molar as defined in accepted descriptions lies under and slightly in advance of the infra-orbital foramen, a remarkable position for it when the greatly reduced facial axis is borne in mind.

A striking peculiarity is seen in the last upper premolar and both upper molars of *Cephalotes* in the presence of a longitudinal ridge on the grinding surface of the tooth back of the paracone. The ridge lies in the middle of the tooth. It is rudimental in the premolar and the last molar but is trenchant in the first molar.

In the lower jaw of *Cephalotes* the teeth present similar peculiarities to those of the upper with the exception that the longitudinal ridge is absent from the last premolar, is rudimental in the first and last molar but well developed in the second. The single specimen of *Cephalotes* examined was a young adult and the premaxillaries were united.

The following were ordered to be printed:—

MINERAL LOCALITIES OF PHILADELPHIA AND VICINITY.

BY THEODORE D. RAND, WILLIAM W. JEFFERIS AND J. T. M. CARDEZA, M. D.

The vicinity of Philadelphia has long been famed for the number of its mineral localities and the remarkable abundance and variety of species and specimens. The fact that these have been found chiefly in mining and quarrying operations of limited extent, many of them of short duration, added to the fact that the region has rapidly filled up with a dense population, so that noted localities have been covered with buildings, while others have apparently been exhausted, led one of the writers to suggest that those most familiar with the occurrence of these minerals during the last half century should publish jointly, and in connected form, an account of the localities more nearly complete than any now existing.

In doing this each has taken the region with which he is most familiar, assisted, however, by the others. No mineral has been mentioned without qualification unless known to one of the writers to have been found at the locality. It is believed that few omissions will be found, but the authors will be thankful for further information from any one knowing additional facts, and such facts will be incorporated in a subsequent paper with due credit.

The authors desire to express their acknowledgment to Messrs. Samuel Tyson, John Smedley, Joseph Willcox, Edward D. Drown and Lewis Woolman for valuable information incorporated in these notes.

The Minerals of Philadelphia and the Territory Adjoining on the Northwest.—By Theo. D. Rand.

A large part of Philadelphia is covered with the Delaware River gravels and clays, but most of the streams have cut through this covering and have exposed the underlying rocks. Owing to the demand for building materials many quarries have been opened, but few of any great extent. The sites of many of these are now covered by buildings. The rocks underlying the gravels and clays are gneisses and mica schists, usually with a strike of about N. 60° E. and a generally northwardly dip; they are often decomposed to a considerable depth. Their best exposure is along the Schuylkill River. Ascending the Schuylkill, the first exposure occurs at Gray's Ferry: a decomposed, highly feldspathic gneiss, of which the feld-

spar has become kaolin and the mica, in some cases, a vermiculite. Mill Creek flows into the Schuylkill River about three hundred yards above Gray's Ferry, and on its banks some quarrying has been done in the mica schist, but no minerals were found except apatite and albite in poor specimens. In the sand of the Schuylkill above Gray's Ferry, and probably elsewhere, small zircons occur.

On mica schist rocks near Gray's Ferry, exposed in a cut of the Philadelphia, Wilmington and Baltimore R. R., an efflorescence proved to be glauberite but it is possible that this may have been derived from the gunpowder used in blasting.

The mica schists continue about two miles up stream to Fairmount, whose bold hill is composed of a gneiss which apparently rises as an anticlinal through the schists and is exposed by erosion On the western side of the river this rock was largely quarried. The first quarry opened was immediately on the river bank. When the inclined plane was abandoned the Pennsylvania Railroad made a curved cut through these rocks extending from about 30th Street to 34th Street, and a large quarry, or a series of quarries afterwards merged into one, was opened on the southwest side of the railroad. Subsequently the bluff between the railroad and the river was largely quarried away, leaving an almost vertical wall of some fifty feet in height. This gneiss, identical with that found on Ridley and Crum Creeks in Delaware County, contained segregated masses of coarse orthoclase-albite-muscovite-granite. In this granite most of the minerals were found. Those identified are as follows:

Orthoclase in fine crystals, nearly all obtained from one highly quartzose granite bed near the river.

Albite, found with the orthoclase, but usually somewhat decomposed, and sometimes wholly converted into kaolin, the orthoclase remaining unchanged.

Tourmaline, black, in good crystals, sometimes terminated and sometimes large, but usually very brittle, so that good specimens were difficult to procure.

Beryl, rare and in small crystals, sometimes much decomposed.

Autunnite occurred in crystals and also as crystalline coatings loosely implanted on the rock. It was at times quite abundant and in very fine specimens. It was not usually in the granite but chiefly occurred in seams in the gneiss.

Chalcolite, perhaps a half dozen specimens were found associated with the autunnite.

Uranochre, one specimen, probably this species.

Garnet occurred, but the specimens were neither fine nor abundant. One specimen of transparent or precious garnet was found.

Chalcopyrite and malachite in poor specimens.

Bismuthinite, one specimen, was found in the granite on the river bank which afforded the fine orthoclase crystals. It is a small group of crystals imbedded in tourmaline.

Muscovite, biotite and pyrite and two specimens of hyalite colored yellow by uranium were found.

Northeast of Fairmount, along the line of the Reading Railroad, and to the north of the latter was high ground chiefly of gneiss, probably the same as that at Fairmount but much decomposed. In the granitic beds of this gneiss good crystals of muscovite occurred. All this region has long been built over.

Northwest of the Fairmount gneiss occur mica schists and hornblende schists which have been quarried along the Schuylkill and in West Philadelphia. The minerals found in this region are not numerous. On the left bank of the river about a quarter of a mile above Fairmount, a promontory of gneiss including some syenite formerly projected into the river, terminated by a rock covered during high water, known as Turtle rock. When the Park drive along the river was constructed, this rock was covered and the adjacent bluff partly quarried away. Here a few quite good specimens of chabazite were obtained, also hornblende in long bladed crystallizations.

Between Turtle rock and Girard Avenue bridge, bucholzite was formerly found.

In the mica schists of the tunnel in the Park north of Girard Avenue, and also in a quarry on Girard Avenue about 38th Street, menaccanite occurred in rough crystals. At the tunnel Mr. Howard Parker found a specimen in which three tabular crystals were curved into concentric semi-circles, the inner one with a diameter of two inches, the outer of three and a quarter inches. The crystals were about one-eighth of an inch in thickness with a quartz parting from 0 to $\frac{1}{8}$ of an inch; a separate flat crystal occupied the radius of the semicircle opposite the three. The exposed ends of these crystals were broken but they were evidently upwards of two inches in length along the axis of the semicircle.

At the quarry near 38th Street, one specimen contained six crystals within 3 x 4 inches, the crystals measuring upwards of an inch in length but being rough except upon the tabular surface.

On the Pennsylvania Railroad, about 36th Street, was a small quarry in mica schist. Here was found a rock formed of garnet in minute crystals of much brilliancy and of a yellowish-red color under the microscope but of a dark red in mass. It varied from almost pure garnet to a gneiss containing minute garnets.

In granitic veins or beds in these schists the mica is generally muscovite, intermixed with a very dark, nearly black mica, and the two occur intercrystallized, occasionally in remarkable specimens some of which are figured in the Report of the 2nd Geological Survey of Pennsylvania, Vol. C^5. In much of the muscovite, hexagonal rhombs, invisible or rarely visible to the naked eye, appear under the microscope. On the northwesterly border of these schists bucholzite, forming a schist, is abundant, especially near Park Station, Schuylkill Valley Railroad. In a quarry south of the Station, and west of the railroad, chalcopyrite, malachite and chrysocolla occurred in hornblende gneiss interstratified in the bucholzite bearing mica schists.

Between these schists and the overlying gravel is frequently found a black friable conglomerate, the cement of which is wad containing cobalt. It can be found in many places.

Included in the mica schists are strata of hornblende gneiss, sometimes nearly pure hornblende. Immediately above the old Columbia Bridge in hornblende gneiss was the well-known laumontite locality. Good specimens were obtained on only two occasions, the first when an ice-house was built there about 1850 and the rock was quarried to make room for it and to build it, and many years subsequently, when the first ice house having burned down, a larger one was erected in its place. Mehlzeolite was abundant and may still be obtained, but well crystallized laumontite was rare. Good crystals, however, were obtained measuring over three-quarters of an inch in length, together with indifferent specimens of natrolite and heulandite and of crystallized quartz.

As an efflorescence on these hornblende rocks alunogen and halotrichite occur occasionally, but on the Pennsylvania Railroad at 59th street there was an old quarry in a peculiar pyritiferous gneiss and felsite. This quarry was opened for railroad ballast, for which purpose the rock was used to a considerable extent before its rapid

decomposition was known. At this point halotrichite was at times very abundant and in quite large masses, due to the fact that the rock in question seems to lie in a synclinal, the axis of which rises rapidly southwestward, forming on the northeast side a series of nooks protected by overhanging ledges, so that the halotrichite formed was protected from the weather. Associated with this is a subsulphate of iron, or iron sinter, probably glockerite, also alunogen.

Pebbles of many varieties of quartz, jasper, basanite, etc., have been found in the gravel which overspreads a large part of Philadelphia.

All the rocks mentioned above have a general northeast and southwest strike, but there is a belt of very hard gneiss extending from Frankford to the Wissahickon, with a strike nearly west, probably rising on the crest of an anticlinal wave or possibly an intrusive mass. This gneiss being hard and quite uniform, with a straight fracture, makes a valuable building stone, and it has been quarried at several points, at some quite largely. It varies in texture from a rather coarse granitic or syenitic gneiss to an almost cryptocrystalline felsite or granulite. Granite segregations are not common, but they are sometimes large and chiefly of orthoclase. The largest quarries of this are at Frankford. Here the minerals were finest and most abundant. Chief among these was stilbite, rarely in crystalline forms, usually in stellate radiations on the surface of what the quarrymen call "heads" in the gneiss, that is joint planes at right angles, or nearly so, to the bedding. This was very abundant, many tons of rock covered with it being exposed at a single blast, and some of it was beautiful, but, occurring as it did on this hard rock, and on faces at right angles to the cleavage, it was often difficult to procure specimens in the midst of great abundance. Fortunately, at times, there were subordinate joints close to the main one; these, too, would be filled with stilbite and along such line the rock would split easily. Usually the coating was very thin, almost immeasurable, but occasionally the joint would widen, and the stilbite would occur, half an inch or more in thickness. With the stilbite is associated, rarely, apophyllite in fine crystals some of them half an inch across, usually opaque glassy-white but sometimes colorless and transparent.

Molybdenite occurs imbedded in the gneiss, sometimes in large masses (one of over a pound weight of pure molybdenite) and also

in crystals which for perfection are probably unequalled. One of about the size of a pea is almost perfect on all sides, having the prism and two domes. One crystal, not perfect but showing five planes, measured 2¼ x 4 inches, and others, showing all the prismatic planes, 1¼ x 2 inches.

The minerals described occurred in the largest quarry, situated northeast of Frankford Creek and between Adams and Church Streets, chiefly towards the northern end of the quarry. In the gneiss at the extreme south end of this quarry was a bed of orthoclase in which was found the randite, usually as a very thin coating on orthoclase, sometimes in groups of microscopic acicular crystals, occasionally imbedded in calcite.

Some of the orthoclase of this quarry has a pink tint, due, as shown by the microscope, to minute crystals, probably of gothite. Tourmaline occurred in poor crystals and also as a rock-like mass coating the gneiss. Muscovite is found, but in poor specimens; also lepidomelane in large cleavable masses. Epidote and sphene, the latter in minute but perfect crystals, were found rarely.

In a small quarry, adjacent to the above, lying across Church Street, was a small bed of calcite in the gneiss containing fine crystals of epidote, some an inch or two long, terminated, and one, measuring ⅞ x 2¼ inches, showing prism faces only, but those brilliant and perfect. Crystallized hornblende was sometimes found but was rare. Hyalite containing uranium was also found.

Beside these the following were found in indifferent specimens: Iceland spar, chalcopyrite, bornite, malachite, chrysocolla, apatite, fluorite.

On Frankford Creek, above this quarry, there is a granite containing reddish orthoclase and greenish oligoclase.

In a small quarry on Little Tacony Creek west of Frankford Road apophyllite was found; the first place at which it was discovered in this vicinity.

In its westward strike this Frankford gneiss is next met with near Wayne Junction, Germantown. The railroad here crosses the turnpike, or Germantown Road, and formerly there was a large quarry in rock very like that of Frankford, except that near the surface it was much decomposed. This was the locality of the philadelphite which occurred as the mica in a schist, and also in small veins in the rock. From the occurrence deeper in the quarry of precisely similiar veins of hornblende and the fact that the hard

hornblende gneiss of the lower part of the quarry seemed to decompose into the philadelphite schist near the surface, I think the philadelphite is due to the alteration of hornblende.

Except sphene and bornite I know of no other mineral found here. About a quarter of a mile further west in a road-cutting were large quantities of a feldspar, probably orthoclase containing imperfect crystals of a black mica, probably lepidomelane, frequently five or six inches in length and not over an inch across. Further west and close to the Wissahickon is the well known McKinney's quarry to which the attention of mineralogists was first called by the abundance of apatite. The gneiss here is very regular and of excellent quality. In a bed of feldspar met with about 1850 rough irregular crystals of apatite, some a foot long, were found abundantly. Besides this the following were found; natrolite, heulandite, laumontite, hornblende, bornite, chalcopyrite, malachite, chrysocolla, fahlunite, sphene and a micaceous mineral resembling philadelphite. Some of the laumontite was colored green by copper.

Northwest of the Philadelphia mica schists and gneisses, from the Schuylkill to near Morton Station, southeast of Media, extends an outcrop of porphyritic gneiss which appears to include some small schist areas, and this is followed by schists called by Mr. Hall the Manayunk schists, very similar to those on the southeast of the porphyry. Both the porphyry and the schists are very barren of minerals. The porphyry is, of course, full of feldspar (orthoclase) crystals usually if not invariably twinned, but it is impossible to detach them from the gangue, and nothing but sections can be had. In the porphyry, granitic segregations occur, composed chiefly of a reddish orthoclase making sometimes a graphic granite. Quartz is much less in quantity than the orthoclase, and mica (muscovite) even less than the quartz. Rarely in this granite occurs black tourmaline in poor specimens. Near West Laurel Hill Cemetery minute sphenes occur in the gneiss which is there very fine grained. Northwest of the bridge of the Reading Railroad over the Schuylkill at the Falls was formerly a large quarry in a gneiss resembling the Fairmount gneiss, but harder.

On the west bank of the Schuylkill, just above the Park bridge, is a quarry which at one time was largely wrought. The rock is not distinctly porphyritic, and is very variable in its different strata, passing from a highly felspathic gneiss to a mica schist, and from

hornblende gneiss to quartzite. This quarry only, among the large number in the porphyritic rock and adjacent schists, is worthy of the name of a mineral locality; no fine specimens were found, but the following occurred: quartz in modified crystals, epidote, magnetopyrite, calcite in dog-tooth crystals, krokidolite, garnet, laumontite, and coatings of halotrichite. On one occasion the sap from a broken root of an oak in the soil over the quarry had trickled down over the rocks whence the halotrichite effloresced, forming a black band of native ink. Rhodonite is reported to have been found in this quarry but I have not seen it.

Northwest of the Manayunk schists is another series, termed by Mr. Hall the Chestnut Hill schists. Both series contain numerous garnets but the Chestnut Hill schists contain them in largest quantity. They are very abundant, sometimes crystallized, rarely large, always dull and usually rough.

In both these schists occur outcrops of magnesian rocks. The most important of these, mineralogically, except possibly the outcrops near Media, is that which is known as the steatite belt which extends from Chestnut Hill, Philadelphia, to Bryn Mawr. It is well exposed on the Wissahickon but on the Schuylkill, at the northwesterly line between Philadelphia and Montgomery County, it has been largely quarried for over a century and has yielded quite a variety of minerals, as follows: talc, rarely in crystals, abundant massive and sometimes in beautiful green translucent specimens; dolomite, massive very abundant, sometimes good cleavage specimens associated with talc are obtained; it occurs also crystallized in the ordinary form of pearl spar, of which some beautiful specimens have been obtained, also in six-sided prisms with terminations, and rarely in a form very near a cube; breunnerite, in poor specimens, at the old soapstone quarry on the east bank of the river, but in crystals quite perfect and more than an inch across, at the quarry on the west bank; magnetite in octahedra in chlorite; tremolite, actinolite, chlorite, hallite, staurolite, millerite, bornite, chalcopyrite, malachite, chrysocolla, magnetopyrite, garnet, apatite, genthite, epsomite, chalcanthite, aragonite, zoisite, pyrophyllite, barite and one specimen of rutile in dolomite. Associated with the steatite is a rock occurring in vast quantity, the mass being steatite, with apparently nodules of serpentine scattered through. At times these show the crystalline form of staurolite, and they are, in part at least, pseudomorphs of serpentine after staurolite.

On the right bank of the river, besides the breunnerite, asbestus was at one time found in considerable quantity.

About a half mile above the soapstone quarry and a quarter of a mile westward from the river was Rose's quarry, in a hard black serpentine of the Lafayette belt. Here were found asbestus, enstatite, Schiller spar and antigorite.

On the Wissahickon, the line of demarkation between the Manayunk schists and the Chestnut Hill schists is obscure. Below Gorgas' Lane menaccanite in quartz occurred. Above Gorgas' Lane was found halotrichite. Near Cresheim Creek antholite in radiated masses is abundant, also staurolite and kyanite in the mica schists, in poor specimens, and garnets in great quantity but poor. Very recently fine kyanite was obtained. Where the steatite belt crosses, near Thorp's Lane, magnetite in octahedra, talc and steatite are found. Hyalite is found occasionally coating the schists.

On the Schuylkill, the tunnel of the Reading Railroad through the Manayunk schists at Flat Rock afforded fine specimens of red stilbite, also heulandite, beryl and calcite. On the left bank, nearly opposite the tunnel, were found brown spar and ilvaite. At Heacock's quarry in the Chestnut Hill schists at Jenkintown, North Pennsylvania Railroad, Mr. Edward D. Drown found an albite granite containing very minute green crystals which a microscopic examination proves to be torbernite. This is an interesting discovery.

Northwest of the Chestnut Hill schists is a hill, often of great height, and almost continuous from Trenton, N. J., to beyond the Brandywine. This is of Laurentian gneiss. It is, except in one place, singularly barren of crystallized or rare minerals. This exception is the well-known Vanartsdalen's quarry near Feasterville, in Bucks County, where a small bed of limestone is exposed and here we find many of the minerals found in the Laurentian limestones of Canada. This is the only observed out-crop of limestone in the whole length of the Laurentian in this part of the State. The rock is mostly granular and crystalline and much mixed with other minerals, particularly phlogopite, pyroxene and graphite. The following minerals have been found:—

Blue quartz, which, while abundant in massive specimens throughout the whole Laurentian range, was in specimens of unusually good color at this quarry; orthoclase, massive, of a gray color, translucent, almost transparent, with the cleavage surfaces very

brilliant; rarely it is beautifully opalescent, resembling labradorite, or even more closely resembling the microcline of Norway; muscovite, rare, of a bright emerald-green color; phlogopite abundant, but not in good specimens; wollastonite, massive, at one time abundant, but usually rare; garnet, massive, not common; pyroxene in its varieties, salite, fassaite; coccolite abundant; sphene in crystals up to an inch in diameter, some quite good, poor specimens abundant; scapolite chiefly in its variety ekebergite, but also in rough crystals, the former abundant; moroxite; zircon very rare, but in beautiful crystals; molybdenite has been reported from this quarry but I think graphite has been mistaken for it; gypsum in poor specimens formed by the action of decomposing pyrite on the limestone.

The graphite, phlogopite, pyroxene, etc., occurred in the limestone often in bands an inch or so wide and a few inches long and remarkably contorted; so much so, that sections roughly broken would occasionally closely simulate letters of the alphabet and the late Mr. Vanartsdalen used to exhibit with much pride the name "George Washington" in these natural stone letters remarkably perfect except in such details as the cross of the A.

In the Laurentian at Trenton and also at Camp Hill near Willow Grove small zircons occur, also, in many places loose in the soil. I know of no minerals in this belt elsewhere except the ordinary constituents of the gneiss: quartz, generally bluish or milky, orthoclase, a triclinic feldspar, hornblende, magnetite and garnet, and also, at one locality near Radnor Station in a trap, labradorite and hypersthene.

Northwestward of the Laurentian for nearly its whole extent is a limestone valley in which, or bordering it, are schists, those near the Laurentian very closely resembling the Manayunk and Chestnut Hill schists, and in many places near the limestone, unctuous clays carrying much limonite. In the limestone many quarries have been opened, some of them large and deep, especially along a line near the southeastern margin, where a bed of the limestone has been converted into marble. The explorations for iron ore have been more numerous than extensive, but in some places vast quantities have been taken out and used chiefly at adjacent furnaces.

At the limestone and marble quarries there is almost nothing of mineralogical interest: calcite in poor crystals, small quartz crystals, damourite in sheets and coatings comprise all, with the following exceptions:—

The most noted marble quarry is at Marble Hall, Montgomery County, on the Ridge Road about fourteen miles from Philadelphia. This yielded fine statuary marble and was wrought as an open quarry to a depth, I am informed, of over three hundred feet; near by lignite and iron pyrites occur.

It has been suggested that this marble is due to the alteration of the limestone by the Conshohocken trap dyke which is near its northwesterly side. Inasmuch as there is ordinary limestone between the marble and the dyke and the marble occurs also at a distance from the dyke as at Potts and Henderson's quarries, this view seems untenable. At Conshohocken, in the cut of the Schuylkill Valley Railroad, the trap dyke was almost if not quite in contact with the limestone, which showed no change from the ordinary limestone of the region.

Northeast of this was a smaller quarry in an inferior marble, and in this was once found a mass of barite of many tons weight almost indistinguishable from the marble except by its weight. It is a tradition that it was supposed to be marble until the hoisting tackle having parted three times successively while attempting to lift a not unusually large block, an investigation showed that it weighed one and one-third times the same bulk of marble. Carbonate of strontia was reported from this vicinity, but I think it a mistake.

Mr. Jefferis informs me that in 1837 fine crystals of dog-tooth spar were found in quantity at Marble Hall.

East of the Schuylkill between the limestone and the Laurentian, is a stratum of Cambrian sandstone forming during most of its course a prominent ridge, especially near Edge Hill Station, on the North Pennsylvania Railroad. In this rock, hematite occurs abundantly in brilliant cleavable masses, very rarely crystallized. It is slightly titaniferous, and was found by Mr. Edward D. Drown, upon land belonging to him near Weldon, to contain rutile in interesting specimens.

On the right bank of the Schuylkill, just above Conshohocken, Montgomery County, a large quarry known as Bullock's has been wrought for many years in a limestone much mixed with mica and graphite. The rock is tough and durable and is favorably situated for quarrying. It cleaves in one direction with facility and in the others it is divided by joints many feet apart, enabling stones of almost any size to be readily procured. This renders it the preferred stone in Philadelphia for heavy foundations and it has been

used thus in most of the larger buildings for many years. Minerals are rare in this rock. In seams, poor quartz crystals and pyrite occur, with occasionally small, but very perfect and beautifully modified crystals of calcite. In one seam, near the river, about 1866, a few remarkable crystals of calcite were found, being perfect and doubly terminated hexagonal prisms, with trihedral summits. Aragonite occasionally lines crevices, some specimens being of much beauty.

White cleavable calcite occurs. Phyllite was found in this limestone in 1864 near Plymouth. In the Chester valley fluorite occurs. At Potts' landing galena is said to have occurred in the limestone.

At the limonite mines adjacent to this limestone belt few minerals occur other than the limonite and that usually in specimens not worthy of a place in a mineralogical cabinet. An exception to this was a mine opened near the Edge Hill furnace on the North Pennsylvania Railroad in which at one time a deposit of geodes of limonite of exceptional quality was met with. At this time, besides the limonite, which was in beautiful specimens, the geodes were found lined with fine specimens of göthite, turgite and velvet manganese, psilomelane and braunite.

In 1855 at Colwell's iron furnace on the northeast bank of the Schuylkill at Conshohocken, a few very fine specimens of cacoxenite were found. This came undoubtedly from the immediate vicinity, but from what particular spot could not be ascertained, as ore was hauled to the furnace from many openings.

In a thin stratum on both sides of the Laurentian and near it, hornstone or chert occurs, at times in large quantity, particularly northwest of Chestnut Hill, on the Roberts Road southwest of the Old Lancaster Road near Bryn Mawr, and on the Mattson's Ford Road west of Montgomery Avenue, on the line between Upper and Lower Merion, Montgomery County.

In the township of Upper Merion, close to King of Prussia, quartz crystals were exposed in a cut of the Trenton Cut-off Railroad, west of the road to Radnor. About two miles further east on the same road, and again about a mile from the Schuylkill a quartzose rock filled with cavities studded with quartz crystals was met with in great quantity. In a similar, if not the same, rock near Henderson Station, Chester Valley Railroad, occurred the fossils for which that locality is noted.

About half a mile east of Henderson Station pyrite altered into limonite occurs in good specimens.

Southwest of the Schuylkill, on each side of the Laurentian hill above mentioned, is a line of serpentine outcrops, beginning on the northwest side about three miles from the river and extending thence nearly in a straight line to a point northwest of West Chester. On the southeast side of the Laurentian there is a very small outcrop northeast of the Schuylkill. Southwest of the river, but close to it, is Rose's quarry before mentioned; thence the belt stretches southwestward almost continuously through Lower Merion, Radnor, Marple and Newtown Townships. On this belt few quarries or mines have been opened, Rose's quarry, as before mentioned, yielded enstatite, asbestus, Schiller spar and antigorite.

At Rosemont, where the Pennsylvania Railroad passes this belt, was a quarry, now built over, which afforded a fibrous aragonite.

Where the road from Philadelphia to West Chester crosses the railroad, about a mile east of Newtown Square, remarkable specimens of stalactitic quartz were once found in digging to lay the foundation of a stone wall. The cavities were from one to four inches wide and the stalactites depending, both in the ordinary form and also in curtain-like sheets, formed specimens of great beauty. Further southwest, in the same belt, was Moro Phillips' chrome mine referred to in Dr. Cardeza's notes.

Close by, but probably in a serpentine not connected with the Laurentian, antholite occurs in quantity and in good specimens.

In the belt northwest of the Laurentian, about one-half a mile northwest of Radnor Station, a quarry was opened on land then belonging to John Stacker. In this quarry, and in the vicinity, the following minerals were found:—asbestus, mountain cork, marmolite, chromite, chalcedony, cacholong, drusy quartz, deweylite, genthite, enstatite, dermatin (?), serpentine pseudomorph after asbestus, quartz pseudomorph after asbestus, pimelite, chrysotile, vermiculite.

In the mica schist of Cream Valley, about a mile northwest of Radnor Station, crystals of garnet sometimes an inch in diameter and usually distorted, associated with staurolite are abundant. In the limestone of the same valley, about a mile north of Radnor Station, small brilliant cubes of pyrite were at one time abundant, many of them curiously elongated and flattened.

In the Potsdam sandstone of Cream Valley minute tourmalines are abundant, occurring occasionally in crystals an inch or more in length.

Localities of Chester County. By William W. Jefferis.

Four and a half miles northeast from West Chester in the township of Willistown, Chester County, there is a vein or bed of magnetite in serpentine, some of the specimens showing strong polarity. This was opened about seventy years ago for chrome ore and some five hundred pounds were taken out, but not being chromite the mining was abandoned.

The serpentine continues in a southwest course and is exposed in West Goshen Township, north of West Chester, for a mile or more. Three quarries have been opened for building stone. In one of them, on the farm of the late General George A. McCall, is found chrysotile in small veins.

A few hundred yards west of this is the quarry of William P. Marshall, that has furnished many cabinet specimens of aragonite in small radiated crystals. In seams of the serpentine, dolomite and marmolite are also found.

On the adjacent ridge, drusy quartz was formerly very abundant, also chalcedony and jasper.

At the end of the serpentine ridge, west of Marshall's quarry is a vein of compact talc that was worked by an old mineralogist in 1834, with an idea of making pencils and supplying lyceums with specimens. North of this, on the edge of the serpentine, staurolite and garnets occur.

Half a mile further west is Taylor's quarry and from it have been taken the following minerals:—radiated aragonite (called by the old mineralogists of 1820, radiated carbonate of magnesia), deweylite, kerolite, asbestus, and chromite in octahedral crystals. In the road north of Mr. Taylor's house, staurolites and garnets were formerly abundant.

On the farm of Caleb S. Cope, in East Bradford Township, one mile west from Taylor's, is found talc, some of the specimens containing yellow actinolite. Epidote in quartz also occurs. A short distance west from the talc locality is an old quarry of magnesian limestone which is very fetid when struck.

In the edge of the quarry was found necronite and also cyanite of a fine blue color, which at one time was quite plentiful in an old dam breast adjoining.

Gray cyanite in crystals occurs in a bed of mica schist at both ends of the bridge over the Brandywine at Cope's in East Bradford Township. Blue and green cyanite are also found in the rocks

near and scattered over the fields for the distance of two miles west of the bridge.

On the hill seventy-five yards west of the old Black Horse Tavern in East Bradford Township (in the road) there is a compact talc of a very fine quality which was exposed some four feet in length by two and a half inches in thickness. This appears to occupy fissures in the hornblende rocks along which there has been a motion of the adjacent parts evidenced by the slickensided surfaces of this talc.

In Newlin Township, five miles southwest from the Black Horse locality, there is a large outcrop of serpentine in which numerous lumps of corundum have been found, one of them, lying on the surface, weighed 5,200 pounds. On the north side of the ridge a number of excavations have been made from which several tons have been taken in small pieces. In one of them was found a vein or stratum fourteen feet long by seven feet in breadth and fifty-four feet in depth, a solid mass of corundum and emerylite; on one side of it was a coating of diaspore, three by two feet and two inches thick, well crystallized on the surface, some of the crystals being two inches long. The other minerals found there were lesleyite, pattersonite, gibbsite, indianite, antigorite and spinel. The locality of corundum was first discovered by the digging of a well on the hill south of this, the crystals being found in a decomposed albite. The well was re-opened in 1844 for corundum but was found unproductive and was discontinued after going down fifty feet. Since then a shaft has been sunk near by to the depth of one hundred and fifty feet, with considerable drifting on a vein, and a number of tons of mineral taken out, said to be from a true vein or stratum. This is now worked by a Philadelphia company, with success.

On the same ridge of serpentine, 500 yards east, a quarry of feldspar was opened and several carloads of it sent to the potteries at Trenton. It was highly cleavable and furnished many fine cabinet specimens, also large crystals of tourmaline, garnets and muscovite.

One half mile east of the corundum locality, at the end of the ridge of serpentine, crystals of beryl of green and yellow colors were found abundantly in the soil; one terminated crystal weighed fifty-one pounds. This appeared to come from a vein of quartz and mica in the serpentine.

A short distance southwest from the corundum works a shaft has been sunk and a few tons of the mineral taken out. When first

opened some of the corundum contained the rare mineral euphyllite.

There are no minerals of any note in the serpentine until we reach the southern part of the county where sand chrome occurs in abundance, and thousands of tons have been taken from the soil. Hallite in hexagonal crystals occurs in a vein in East Nottingham Township, also a hard asbestus in stick-like masses two feet long.

In West Nottingham Township, crystals of chromite in octahedrons, roseite (a variety of jefferisite) staurolite, leelite and magnesite occur. Several excavations have been made in search of the latter mineral and many tons of it were sent to Philadelphia to be used in the manufacture of epsom salts.

In the adjoining county of Lancaster, one-half mile from the Maryland line is the celebrated chrome mine known as "Woods' mine." The mine was opened about the year 1835 or 1840, and many thousand tons of chromic iron have been taken from it. The vein was traced to the depth of 700 feet, and in some places was 30 feet thick. It has not been worked for the past ten years, and is now abandoned, and filled with water and debris. About the year 1858 or 1860 brucite was found in abundance, finely crystallized; one of the veins of brucite being a foot in thickness. The following minerals also were found at this mine:—zaratite, kammererite, penninite, deweylite, ouvarovite, picrolite, genthite, baltimorite, dolomite, hydrodolomite, aragonite in delicate radiated crystals and hematite in very fine crystals with penninite. All the minerals found within five miles of the mine have been labelled from Texas, as follows:—williamsite, enstatite, lancasterite, talc, magnetite crystals in chlorite, green tourmaline, limonite pseudomorph after pyrite in modified crystals, steatite, carnelian, jasper, moss agate and drusy quartz.

In the western end of the township of West Town, three miles south of West Chester is the celebrated Birmingham serpentine quarry, perhaps better known as Brinton's quarry. The stone has been used in the principal cities of the United States. The following occur in the quarry:—clinochlore and jefferisite in finer specimens than elsewhere; deweylite, tourmaline, beryl, magnesite, talc, aragonite, in radiated crystals on the serpentine, covering surfaces three by two feet or more; oligoclase, showing fine twinning lines; magnetite, amethyst, etc. The crystals of clinochlore, are found in pockets of talc in the solid serpentine, partially decomposed.

There is also an outcrop of serpentine two and a half miles southwest of West Chester with a vein of aquacreptite through it. This

mineral when immersed in water decrepitates with considerable noise. This locality is in East Bradford township, and amethysts are found in nearly all the fields within half a mile of it.

Half a mile northwest from the Birmingham quarry is Osborn's Hill, in which a mine was opened about the year 1835 for manganese, and half a ton of the black oxide taken from a depth of thirty feet. The vein stone was massive manganesian garnet containing crystals of yellow sphene. Tourmaline, in small crystals in quartz, occurs abundantly, also orthoclase crystallized, on the west side of the hill.

Very few minerals have been found in the hornblende rocks of Chester County, the principal ones being zoisite at the old water works in West Chester, now inaccessible; labradorite, sphene and sunstone, the latter of great brilliancy, were found at Lamborn's mill, one-half mile southeast of Kennett Square; epidote crystals occurred loose in the soil one mile south of the borough; sunstone is also found near Fairville. One-half mile north of Fairville, on the farm of the late William Dilworth, muscovite crystals occur by the hundred in the soil northwest of the house, near the woods.

One-half mile south of Pennsville, on the farm of Jacob Swayne, there is a large deposit of white quartz containing a few crystals of feldspar, and large crystals and plates of muscovite beautifully marked by magnetite and containing compressed crystallized quartz, suitable for the microscope. Some almost perfect crystals from this place measured eighteen inches by twelve or more. A large quantity of merchantable mica was obtained.

In quarrying for limestone in Chester Valley they occasionally find openings or small caves filled with stalagmites and stalactites, some of the latter being a foot or more in length; a few brilliant crystals of pyrite are sometimes found in the limestone, also fluorite and quartz crystals; at the Pennsylvania Railroad quarry, East Caln Township, ankerite.

In the limestone on the Brandywine Creek, about a mile above Chadd's Ford, occurs chondrodite, the only locality of this mineral in the region.

The quarries in West Bradford Township, known as the Poor-house quarries, were opened nearly one hundred years ago and are in a magnesian limestone; in it are found the following minerals:—chesterlite, quartz crystals, rutile in needle-like crystals, some transparent and of a dark ruby color; tremolite and a yellow damourite

in delicate tufts or rosettes. Some two miles to the southwest are the Doe Run lime quarries. These have been extensively worked for over half a century. In them have been found rutile, tremolite and fluorite, the latter only as a thin crust of a deep purple color.

In West Marlborough Township, two miles west of Unionville, are Bailey's lime quarries, containing bladed mussite, crystallized and fibrous tremolite in quantity. Brown and yellow tourmaline in small crystals have also been found in this township.

Limestone has been quarried extensively near the village of Avondale in London Grove Township. Aragonite, brown tourmaline, mountain leather, tremolite and very fine crystals of calcite are the only minerals found in these quarries.

Some years ago a large quarry was opened in the gneiss rocks at Avondale, known as the Toughkenamon hills, and in it bright red iron garnets in dodecahedral crystals were found by the hundred, some of them being three and one-half inches in diameter, also good crystals of tourmaline. A small specimen of graphite was found in this quarry.

Pyrite more or less altered into limonite of a shining dark brown color in cubic crystals of all sizes up to one and one-half inches in diameter are found loose in the soil in the township of East Whiteland and Tredyffrin in abundance; these are sometimes pure limonite.

In the year 1850 an iron mine was opened on the farm of the late Gen. Trimble, in East Whiteland Township, and at the distance of ten feet below the surface was found a horizontal vein of wavellite in stalactites, also radiated and occasionally crystallized. After a few years the mine was abandoned and the locality lost for a time. A shaft or well has since been dug twenty-five feet, striking one of the old drifts and from it were taken a few very fine specimens. Cœruleolactite was found in abundance when the mine was first opened, but as it was thought of no value it was dumped into the excavations left in mining the iron ore and many fine specimens were lost to science.

Rutile, or the mineral known in Sadsbury Township as moneystone, is found loose in the soil for the distance of seven miles along the Chester Valley and particularly near the village of Parkesburg on the farm of Horace A. Beale where crystals have been found weighing three quarters of a pound.

In Uwchlan Township half a mile north of the Eagle tavern massive blue quartz is found in abundance. Graphite is now being mined quite extensively east of the tavern.

A number of iron mines were opened in the vicinity of Kimberton and Yellow Springs, fifty years ago, and many fine specimens of limonite were found, also a half ton or more of a jet black limonite known as melanosiderite. A fine specimen of allophane was found in one of the mines near, and is now in the Vaux collection. It is the only one known from Chester County.

A deposit of limonite was found in West Whiteland Township adjoining the quarry known as Thomas' marble quarry, worked to the depth of 180 feet in the year 1836, and after a few years abandoned. The ore is principally of the variety known as pipe iron ore, but some of it is of a rather different character, for the stalactites or pipes instead of being radiated in structure were composed of concentric layers, making a pipe within a pipe. The deposit being of a very limited extent was soon worked out, and now no trace of it remains.

The following minerals have been found at the Warwick mine holes, at the village of St. Mary's:—magnetite in dodecahedral crystals; actinolite, in small radiated geodes, and a jet black melanite garnet in geodes, with a reddish mineral, said to be orthoclase.

One mile west from St. Mary's are the old Hopewell mines, the ore being magnetite crystallized in octahedrons, with an occasional group of pyrite, and quartz pseudomorph after pyrite.

One-half mile north from the village of Knauertown are the celebrated mines known as the Mines of French Creek, being first worked as Keim's iron mine, afterwards as the Elizabeth copper mines; now being mined for iron. The ore is magnetite mixed with pyrite. Bright pyrite in octahedral crystals with numerous modifications occurs in the vein or wall of calcite; there is also a vein of chalcopyrite adjoining the iron ore vein. The chalcopyrite is crystallized where it adjoins the calcite, making the finest specimens of the mineral known to mineralogists. It also occurs in perfect, isolated tetrahedra. Besides the above the following minerals occur: calcite crystals, aplome garnet, stilbite, apophyllite in remarkable specimens, byssolite, erythrite, hornblende and a feldspar pseudomorph after natrolite.

At the lead mines near Phœnixville, known as the Wheatley and Brookdale mines, the following have been found:—anglesite, cerusite, pyromorphite, wulfenite, descloizite, mimetite, galenite, native cop-

per, chalcopyrite, malachite, azurite, sphalerite, calamine, laumonite, calcite, fluorite, limonite, native sulphur, oxide of manganese, pyrite, barite, covellite, quartz and dolomite, melaconite, quartz pseudomorph after calcite, ankerite.

LOCALITIES OF DELAWARE COUNTY. BY J. T. M. CARDEZA, M. D.

The chief localities for minerals in Delaware County occur in gneissic beds, many of which are isolated in areas of more schistose rocks, or in or near the serpentine outcrops which abound in the central part of the County.

Perhaps the more prolific localities have been in or near the Townships of Ridley and Middletown.

Ridley Township. East of Chester and north of the River Delaware, large quarries have been wrought for many years chiefly in fine grained micaceous gneiss of considerable value for building purposes and for curbstones. Of these Deshong and Leiper's on Ridley Creek and Leiper and Lewis' on Crum Creek are most noted. The gneiss itself contains rarely small garnets and tourmaline, the rarer minerals occurring in coarse granitic veins, beds or segregations in the gneiss.

At Deshong's quarry, as at Leiper's on Ridley Creek, the two being in the same bed, good-sized brilliant garnets have been found together with beryl in hexagonal prisms one-eighth of an inch to one and one-half inches in diameter and from one inch to twelve inches in length, usually pale green and translucent, occasionally bright green and transparent, and a number with fine well terminated crystals. I have a specimen in my cabinet with replacements of the prism faces giving it the appearance of a cylinder. Small well terminated crystals of yellow beryl were found here.

Beryls, some terminated, altered into a granular white substance were recently found. I have in my possession a beryl from this locality, one foot long, two inches in diameter, lying on a bed of crystallized feldspar. Some very fine specimens of tourmaline occur, but being very fragile, are rarely obtained entire; muscovite is abundant but poor. Autunnite and torbernite, in good specimens, in coarse granite, have been obtained; also more rarely uranochre. Fine crystals of orthoclase of different forms have been found, both singly and in groups, the crystals from one-half an inch to six or eight inches in length. In a pocket was found thulite of a beautiful pink color; of this there were very fine specimens, some honeycombed and some

with a few small crystals. Leidyite, a hydrous silicate of iron, is found in granular masses. I have noticed a similar occurrence at Jones' Falls, Baltimore. I allude to the presence of chabazite coated with leidyite and leidyite pseudomorph after chabazite, making haydenite. In Deshong's quarry, in connection with the leidyite, are the same zeolites as at Jones' Falls, viz.: stilbite, heulandite and a few small specimens of beaumontite. In this pocket some small but good crystals of chalybite occurred. Ward's quarry, about one mile above Deshong's, between the Philadelphia Pike and the Delaware River, is similar in geological characteristics and is largely wrought for its stone. Stilbite is found in fine, large radiations.

The quarry of Leiper and Lewis, at Avondale, on Crum Creek, affords very fine garnets, some as much as two or three inches in diameter, as well as very brilliant smaller ones, also tourmaline in terminated crystals, but occurring usually in sections of about one inch to one and a half inches in length, a stratum of granular quartz, a quarter inch or less in thickness, breaking the continuity of the crystal. • Good crystallized orthoclase and beautiful crystals of adularia are found in groups in which are sometimes found small, pale green, or nearly white beryls, well crystallized, with modified terminations. A few terminated yellow beryls have also been found. Mr. Rand reports having collected in this quarry, chalcopyrite, malachite, chrysocolla, hyalite of a bright green color, uranochre, uraninite and bismutite, the last three in very small quantity. Miss M. A. Holmes reports pink zoisite or thulite. At Folsom is a small quarry opened for cellar foundation-stone, in which some good garnets were recently found, one in my possession being as large as a man's fist. In a quarry near Leiperville, owned by John Deshong, but not at present worked, owing to the hardness of the stone (a hornblende gneiss) some pretty garnets, one-half to three-quarters of an inch in diameter, were found in a schistose bed in the gneiss, with also stilbite of a yellow or orange color and in radiations one and one-half to two inches in diameter.

At Bullen's Lane, on Ridley Creek, a quarry, now owned by James Irving but not at present worked, has yielded some very fine crystallized orthoclase in modified forms, some very fine garnets from one inch to one and one-half inches in diameter, crystallized muscovite in quartz, looking as if subjected to enormous compressing force,

the basal planes being rounded and the crystal being not unlike stone arrowheads in form.

Chester Township. In the village of Upland on Chester Creek near Chester, in a quarry formerly worked by Henvis, chabazite of a red color was found. One specimen in possession of Michael Bradley of Chester has with the chabazite, pectolite. Some good crystallized orthoclase of a flesh color was found.

On the Samuel Felton farm, Thurlow, is an altered natrolite in a schistose rock.

At Ship Creek, a tributary of Chester Creek, near Upland in Samuel Crozer's quarry, garnets coated with autunnite, and one fine doubly terminated crystallized orthoclase was found.

In Shaw and Esray's quarry, near Chester, have been found tourmaline, garnet (one as large as a man's fist) crystallized orthoclase, beryl, mostly in process of alteration, but good crystals of a pale green color; smoky quartz in large crystals. I have one in my possession, fourteen inches long, one foot wide and about seven inches thick, two planes of the prism being developed at the expense of the four remaining. An amethyst of the same size and form was also found here. Some good amethysts are found of a deep purple color, also smoky quartz, in crystals six to eight inches long, and three to four inches in diameter encrusted with well crystallized amethysts of good color; also a peculiar feldspar in crystals six to eight inches long and four to six inches across, having the appearance on the surface of having been eroded.

At Cartertown, farm of Peter Green, near Chester, is the old Chester molybdenite locality on Chester Creek above Upland. A few crystals of this mineral were found, with a considerable quantity of the massive mineral, disseminated in quartz, but at present it is scarce. Molybdite occurs with it (Rand). In the same vicinity was sillimanite. A crystal of beryl, of a pale green color, terminated, four inches long, one and a quarter inches thick, was found here in a boulder of granular quartz, and is now in my possession. On this property, on the creek shore, a mine was opened some years ago for copper, but very little sulphide of copper was found, and the mine was abandoned as it required constant pumping.

At Bridgewater, on Chester Creek near Upland, in one of the quarries of John Mullen, in a pocket in the schists, several fine large crystals of sphene occurred, of a yellow and also of a light green

color, some two inches in length. None have been found since, in spite of diligent search.

Darby Township. On Bethel Custer's farm, Glenolden, are good blue kyanite in long blades, and sillimanite.

On the Philadelphia Turnpike, below White Horse tavern, in a ditch on the west side of the road, blades of kyanite occur abundantly, washed out by rains from a schist.

On the farm attached to the White Horse tavern, are gray and blue kyanite and sillimanite.

In digging the cellar and foundation for a barn, on a farm opposite the White Horse tavern, several large boulders of kyanite were found, of a beautiful blue color with blades six to eight inches in length. Along the little stream emptying into Darby Creek at Morris' Ferry, many loose masses of kyanite have been worked out. At Morris' Ferry, in the creek at low water, garnets of good quality have been found in the mud.

Near Landsdowne, smoky quartz, loose in the soil. Mr. Rand has a crystal measuring nine by seven inches.

Near Darby, titaniferous garnet.

At Upper Darby, in a cutting of the proposed Chester County Railroad, Babel quartz and modified quartz crystals, orthoclase crystals.

Nether Providence Township. On the farm of George Sharpless, on Providence road above Shoemakerville about three miles above Chester, a small quarry was opened for stone to pike the road leading to Media, and some remarkable crystals of feldspar doubly terminated and variously modified were found, some eighteen inches by twelve inches were taken out, and at present several are in my possession; also green mica in pretty specimens. In digging a post hole opposite the mansion, a pocket of amethyst was discovered. About a half dozen fine crystals, one and a half to two inches in size and of a deep purple color were obtained.

Near Swarthmore College, andalusite and black tourmaline, not terminated, but the whole crystal tapering from the base in a long cone shape, are found, also orthoclase.

Howard Lewis' farm. Andalusite, tourmaline, yellow beryl. The andalusite crystals were imbedded in quartz, some very large crystals were obtained and some remarkably perfect. A group in the collection of Mr. Theo. D. Rand contains one crystal nearly

perfect on three of its four prismatic planes, and perfectly terminated at both ends.

Upper Providence. On Thomas Reese's farm, orthoclase, cassinite, sunstone and moonstone in striated oligoclase, corundum.

At Blue Hill, prase in magnificent specimens, asbestus, chrysotile in fibres two, and two and one-half inches in length, actinolite, drusy quartz and chromite in large crystals.

Lower Chichester and Vicinity. On farm of William Trainer, on a knoll near the Linwood mill dam, were found crystals of orthoclase and tourmaline, and large crystals of beryl of a pale green color, some mottled yellow and green externally and pale green internally, opaque, two inches in diameter. I have in my possession a specimen from this place, one foot in length and an inch and a half in diameter, with another crystal, about six inches long and one inch in diameter attached to it at right angles, I have also a specimen two and one half inches in diameter with replacements on the termination. This beryl occurs in a granular quartz, in boulders one to ten feet below the surface, although large specimens have been ploughed up on the surface. There is a deposit of good kaolin near the spring house on the same farm.

In quarry of Benjamin Johnson, garnets.

On Robert Loughead's farm, kaolin.

On farm of Matthew Boyd, some specimens of blue kyanite have been found.

Upper Chichester. A few good garnets, of the spessartite variety, about one inch in diameter, were found in the feldspar quarry of John B. McCay, on the north branch of Naaman's Creek.

On the same farm, in a wash-out of the Baltimore and Ohio Railroad, many fine spessartite garnets were found in a feldspar deposit which occurred in broken blocks, presenting almost the appearance of masonry; some good sphene of a yellow color, from a half inch to one inch in length, are also found here.

In the same neighborhood, on the farm of J. B. Okie, amethyst crystals have been found. Of these one has been cut and mounted as a gem.

Farm of John Carrol, adjoining that of J. B. Okie, a quarry of feldspar, for the manufacture of porcelain and for dental purposes, has been opened.

Near Chelsea, on the farm of Stephen White, green garnet, gahnite, and flattened garnet, in mica occur.

Aston. Farm of Wm. Hannum, near Village Green, a large deposit of asbestus of good quality is found and is about to be mined.

On Judge Tyson's farm, near Village Green, acicular tourmaline.

On Brown's farm, adjoining Judge Tyson's, bronze corundum, corundum passing into margarite, and margarite pseudomorph after corundum.

An old and prolific deposit of amethyst was on Chester Creek near Dutton's mill. A vein runs across the road which leads from Judge Tyson's to Dutton's mill, and large numbers of crystallized amethysts have been dug out for years and probably by deeper digging many more can be secured. This amethyst is of a beautiful purple color. A new road was laid out a few years ago along Chester Creek from Upland to Dutton's mills on the east side of the creek, and on the McCall farm a pocket of fine amethyst of good color was found. On the farm connected with the Dutton's mills are boulders of antholite. On farm of Thomas Pancoast, asbestus.

North of Dutton's mills some remarkable crystals of muscovite were found.

At Llewellen, staurolite.

On John Halberset's farm, enstatite, drusy quartz, hornblende. Near Morgan Station, quartz crystals, modified, with implanted minute crystals of ruby colored rutile.

Bethel Township. On a farm at one time occupied by James Lancaster a large deposit of granular garnet is now largely mined by a company for the manufacture of sand paper. It is said to be a very superior article. Some gems have been found here. At Green's Creek above Chelsea, garnets have been washed out of the sand of the creek bed. Some fine gems have been cut from garnets from this locality.

Concord. About one mile above Chelsea, on the farm of Harry Hannum, a large rock about twenty feet in diameter and about ten feet high rose up solitary on the lot. This rock consisted of antholite in radiations from three to four inches in diameter. It presented a peculiar and striking appearance before it was partly blasted away.

On the Singer farm, antholite and enstatite were abundant, clinochlore also occurs.

On Samuel McClellan's farm, asbestus, clinochlore, tourmaline.

On Mary Palmer's farm, bronzite, diaclasite, a beautiful mineral in yellow fibres one to two inches long. Of this mineral Dana gives

no American locality. Enstatite and antholite in pretty varieties are found.

On Randolph farm, Rose tree, amethyst in the soil, a manganese sand.

On James Worral's farm, andalusite, fine large crystals, some large groups. A crystal, nine inches long two and one-half inches thick, is in the possession of Joseph Willcox. Very fine crystallized amethyst, two and a half inches by eight inches, and many smaller ones of a deep purple color, beryl, apatite, tourmaline have also been found.

Morgan Hunter's farm near the Rose Tree Inn, andalusite, several fine crystallized amethysts. I have one from this locality three by three inches of a deep blue color; amouite after andalusite; antholite after andalusite.

Middletown. On Joel Sharpless' farm, a quarry was opened about five years ago for feldspar and a considerable quantity taken out, when it was abandoned. A very large deposit of mica, transparent and colorless except for some included magnetite markings, was found and utilized for stove doors. Beautiful microscopic crystals of quartz occur occasionally between the laminæ, also very pretty flattened crystalline films of quartz. Beryls mostly altered entirely or in process of alteration, terminated or in terminated sections, varying from one inch to nine inches in diameter, and from one inch to fifteen inches in length were found. I have one in my cabinet, seven inches in diameter and fifteen inches in length, very little altered, terminated and of a pale green color, but opaque. Gahnite in small crystals was found, also small flattened green garnets. Raud reports finding rose quartz near the quarry; along the road adjoining Isaac Evans' farm occur orthoclase and muscovite.

On Albert Darlington's farm, orthoclase.

On Humphrey Marshall's farm, amethyst in a quartz vein in hornblende rock, rutile in crystallized amethyst.

On John Tyler's farm, Dismal run, crystallized rutile, sillimanite, vermiculite in small crystals, ferruginous quartz, prase in mammillary masses.

At Bishop's mill, garnets, some very fine ones, two inches in diameter, plumose mica.

On Walker Yarnall's farm, cassinite, smoky quartz, some good specimens.

On Edward Smedley's farm, large boulders of corundum, asbestus, talc, muscovite, translucent across the prisms.

On George Williams' farm, corundum.

On John Smedley's farm, a few fine crystals of corundum.

On Phillip Mullin's farm, near Black Horse, some fine crystallized corundum was ploughed up in the soil, and collected after heavy rains.

In the ditch, on the west side of the road, going towards the Black Horse, and opposite the Mullen farm, many crystals of corundum have been picked up, washed out after heavy rains.

On a farm opposite P. Mullen's, corundum in albite has been found. A large pit was sunk and crystallized corundum, of a gray color and of a good quality for commercial purposes, was obtained. Many doubly terminated crystals from one to two inches long were found.

On Ahinam Smedley's farm, corundum, albite, beryl, (some good ones), columbite, fergusonite, asbestus.

At Mineral Hill, farm of Lewis Moore, rock chrome, abundant.

In Crump's Mineral Hill serpentine quarry, magnesite, chlorite, deweylite, talc.

On John Smith's farm, near Black Horse, beryl, of a dark emerald-green color, in good crystals, out of which some gems have been cut. Albite, vermiculite, tourmaline, sunstone, moonstone, columbite have also been found. A pit was dug for corundum and good specimens obtained; fibrous hornblende, actinolite of various shades of color, and enstatite, have been collected.

Near Institute for Feeble Minded Children, stilbite, drusy quartz, hypersthene.

At the "old chimney," north of Crump's quarry, was a small quarry for green feldspar yielding fine cleavage masses of a beautiful green color; some good crystals were found, but all more or less weathered. Sunstone, moonstone, columbite, a vein half an inch to an inch thick of an undetermined black mineral have also been collected.

On Robert Moss' farm, garnet and staurolite, in schist.

On Walter Beatty's farm, hornblende, titaniferous iron.

On William Bonsal's farm, smoky quartz, actinolite, drusy quartz.

On Charles Mills' farm, enstatite, marmolite, asbestus, boulders containing clinochlore.

On Samuel Jackson's farm, radiated tourmaline.

On Rev. Mr. Ross' farm, pyrite.

On Samuel Wells' farm, magnetite.

On Mathew Dobson's farm, rutile.

On Jesse Hibbard's farm, near Black Horse, chrome sand in washings containing good crystals, and rarely brookite. Actinolite of a deep green color. Moonstone in very fine specimens, stalactitic magnesite, bronzite, corundum in albite.

On road leading from Lima to Wawa, amethyst.

On Media Railroad, near Williamson school, chrysolite.

On Christian Scherz's farm, Black Horse, a peculiar chromic iron and hematitic iron intermixed with corundum.

At Edgar Tyson's Black Horse Tavern, on road going towards Rockdale, one hundred and fifty yards below blacksmith shop, corundum.

Several mines have been started in Middletown of late years for iron ore but have been abandoned, the ore not proving abundant. Some good showy specimens of limonite were found.

At Lenni, at the deep cut of the Media Railroad, vermiculite of a deep green color, also of a bronze and a white color. Leelite, lennilite, delawarite and actinolite, also several masses of small quartz crystals of a pale green color were collected. A serpentine quarry was opened here.

Edgemont. On Alfred James' farm, beryl.

At and near Castle Rock, enstatite, asbestus, chrysotile, talc, limonite in fine specimens showing fibres three inches long, ferruginous quartz, some closely resembling compostella quartz, also, in cavities of honeycomb quartz, microscopic quartz crystals doubly terminated and bright red in color. Under the microscope the crystals are colorless and transparent but each contains a minute red speck which colors the whole to the naked eye. These make beautiful microscopic objects.

Marple. On Major Jones' farm chromic iron.

On Abby Worral farm, andalusite, some good specimens; in the public road near the mansion, amethyst.

On Samuel Sharpless' farm, andalusite, tourmaline.

On Albert Worral farm, tourmaline.

On all the farms passing north, andalusite.

Radnor Township. Moro Philips' chrome mine, chromite, garnet, sphene, asbestus, steatite, limonite, magnetite.

Passing north into Radnor enstatite and asbestiform antholite and antholite containing bronzite and diaclasite are found.

On Mary Palmer's farm in the triangle between the Coopertown-Newtown road, Roberts road and Chester and Radnor road, antholite is abundant.

OBSERVATIONS UPON THE BRAIN OF THE GORILLA.

BY HENRY C. CHAPMAN, M. D.

The brain of the Gorilla has been described by Gratiolet[1], Owen[2], Pansch[3], Thane[4], Bischoff[5] and Broca[6]. It should be mentioned, however, that the brains described by Gratiolet and Owen were in such a decomposed condition as to admit of but little more than a very general description, while the brain described by Pansch was the same that was afterwards described by Thane and Bischoff. Thane, moreover, does not appear to have ever seen the brain of the Gorilla he described, his remarks being based upon copies of the figures illustrating Pansch's paper. Bischoff, however, had the opportunity of studying the brain itself, the specimen previously described by Pansch having been submitted to him for examination, at his request, by Dr. Bolau. Finally, the brain described by Broca differed so much from that described by Bischoff that the latter wrote to Broca to say that he believed the brain described by the latter was not that of a Gorilla at all, but that of a Chimpanzee. It was undoubtedly, however, a Gorilla's brain. Since then Pansch has had the opportunity of dissecting three other Gorilla's brains the examination of which confirms his previous conclusions, based upon the brain of the Gorilla studied by Bischoff and himself.

It will be seen from the above resumé of the literature of the subject, that the opportunities of studying the brain of the Gorilla have been very few. In fact up to the present time, of the few Gorilla brains that have been obtained, supposing that described by Broca to have been a Gorilla, only five were in such a condition when received as to permit of description. It is to be hoped, therefore, that the following brief description of the brain of the Gorilla obtained in the neighborhood of the Gaboon river by the Rev. R. H. Nassau and presented by him to the Academy, through the courtesy of Dr. T. G. Morton, together with two others to be mentioned hereafter, will not be considered as superfluous, especially as it differs in several respects from the brains previously described.

[1] Comptes Rendus, 1860.
[2] Fullerian lecture, reported in Athenæum, March 23rd, 1861.
[3] Abhandlungen aus dem Gebiete der Naturwissenschaften, Hamburg, 1876, Jahresbericht über die Fortschritte der Anat. und Phys., 1879.
[4] Nature, Dec. 14th, 1876.
[5] Sitzungsberichte Acad. der Wissenschaften zu München, Band vii, 1877.
[6] Revue Anthropologique, 1878.

The brain, that of a young Gorilla, weighed one hundred and fifty grammes and measured ninety millimetres in length, seventy-five millimetres in breadth and sixty millimetres in height and was somewhat smaller than either of the brains previously described by Pansch and Broca. Each hemisphere of the cerebrum of the Gorilla, like that of man, is incompletely divided by more or less well defined and deep fissures into the following five divisions or lobes, viz: the frontal, parietal, occipital, temporal, and central lobes. The fissure of Sylvius, Pl. XI, fig. 2 S, begins at the base of the hemisphere behind the origin of the olfactory nerves, and laterally from the optic chiasma. Passing thence outwardly it reaches the arched lateral surface of the hemisphere and divides into two branches. The posterior branch, Pl. XI, fig. 2 S′, the longest of the two passing obliquely upward and backward terminates in the supra-marginal convolution of the parietal lobe. The anterior vertical branch, Pl. XI, fig. 2 S″, the smallest of the two into which the Sylvian fissure divides, passing obliquely forward and then upward and slightly backward, terminates in that part of the third frontal convolution which is situated below the second frontal fissure and in front of the pre-central fissure. The anterior horizontal branch, the third into which the Sylvian fissure divides in the brain of Man, and usually undescribed even in special works upon the brain, while absent in this specimen appears to have been present in the brain of the Gorilla described by Broca. It should be mentioned in this connection, that this fissure, regarded by Broca as being the anterior horizontal branch of the fissure of Sylvius, was described by Pansch as the anterior vertical branch, and by Bischoff as the orbital branch, both Bischoff and Broca regarding the slight indentation above but not passing into the posterior branch of the Sylvian fissure, as the ascending vertical branch. Such an indentation is present, at least in the right hemisphere of the brain of the Gorilla under consideration, but we cannot attach to it the morphological significance attributed to it.

The difference in interpretation of this fissure may be due to the fact of the brains described by Bischoff and Broca differing from each other and from that now described. Within the angle formed by the anterior and posterior branches of the Sylvian fissure may be seen, on the right side at least, of the brain of our Gorilla, the fifth lobe or island of Reil, the operculum leaving it partly uncovered. On the left side of the brain, however, the operculum fits so closely into the angle just referred to, that the island of Reil is completely

concealed. The operculum in the brain of the Gorilla, as in that of Man, is formed partly by the lower ends of the two central convolutions where they pass into each other, and partly by portions of the third frontal convolution and lower parietal lobule. The fissure of Sylvius, with its posterior branch, separates the frontal and parietal lobes from the temporal lobe. The central fissure, or fissure of Rolando, Pl. XI, figs. 1, 2 R, invariably present in the human brain as well as in that of most monkeys, is well marked in the brain of the Gorilla. Beginning on the upper surface of the hemisphere, slightly posterior to the middle line, it passes obliquely forward and downward to terminate near the upper border of the posterior branch of the Sylvian fissure, and is larger in the left than in the right hemisphere. The central fissure divides quite naturally in the Gorilla the frontal from the parietal lobes upon the upper surface of the hemisphere. The central fissure in its whole length is bordered, as in Man, by two convolutions, the anterior and posterior central convolutions, Pl. XI, fig. 2 a, b. The former we regard as belonging to the frontal, the latter to the parietal lobes. It has already been mentioned that the lower ends of the two central convolutions, where they pass into each other around the end of the central fissure, enter into the formation of the operculum.

While this is the case in the left hemisphere, it is not strictly so in the right one, since the central fissure is not only shorter on the right side than on the left, but also on account of the precentral fissure on the right side being longer than on the left, it passes down in front of the central fissure and almost reaches the posterior branch of the Sylvian fissure. The anterior central convolution, Pl. XI, figs. 1, 2 a, may be considered as giving origin at different levels from above downward to the superior, middle and inferior frontal convolutions, Pl. XI, figs. 2 c, d, e. The superior or first frontal convolution, Pl. XI, fig. 2 c, is separated from the middle or second frontal convolution, Pl. XI, fig. 2 d, by the first frontal fissure, and the second frontal convolution, Pl. XI, fig. 2 d, from the inferior or third frontal convolution, Pl. XI, fig. 2 e, by the second frontal fissure. It is impossible to say whether the convolution, which, passing downward and forward and bending around reaches the orbital surface of the frontal lobe, should be regarded as the continuation of the first or second frontal convolution or not. That the inferior part of the frontal lobe of the brain of the Gorilla, Pl. XI, fig. 2 e, should be regarded as homologous with at least

part of the third or inferior frontal convolution of the brain of Man, is shown by the fact that the convolution in question not only surrounds the end of the anterior vertical branch of the Sylvian fissure, but its inferior lower part passes as an arched convolution under the operculum into the island of Reil. As a confirmation of this view it will be observed that the pre-central fissure, into which the second frontal fissure runs, Pl. XI, fig. 2 d, passes downward between the anterior vertical branch of the fissure of Sylvius and the central fissure. The frontal lobes of the Gorilla differ, however, from those of Man in their anterior portion terminating in a point. The inferior or third frontal convolution in the brain of the Gorilla differs, especially from the corresponding convolution in Man, in not only being relatively smaller but in its orbital surface being hollowed out to such an extent that the portion of the inferior frontal convolution which in man surrounds or is below the anterior branch of the fissure of Sylvius, is absent. Indeed this should be so if, as we have just supposed, the anterior horizontal branch of the fissure of Sylvius is absent. It is hardly to be expected, therefore, that in addition to the olfactory fissure both the orbital fissure and the solco cruciform of Rolando[1] should be present in the brain of the Gorilla, especially as the fissures on the orbital surface of the frontal lobe in the brain of Man are variable in form. Only one fissure, in addition to the olfactory, is present in the orbital surface of the frontal lobe of the Gorilla's brain, and that resembles in both hemispheres rather the cruciform than the orbital fissure of Man.

If the interpretation just offered of the convolutions of the frontal lobe of the brain of the Gorilla be correct, it follows that the frontal lobe of the brain of the monkeys below the Gibbon must consist essentially of only two convolutions, the superior and middle frontal, the inferior frontal convolution being in them but little developed, as in *Macacus*, or absent altogether as in *Cercopithecus*. If such be the case then the convolution in monkeys described by Gratiolet[2] as being the inferior or third frontal must be regarded as being the middle or second frontal convolution, the inferior frontal convolution being but little, if at all developed. The view just offered, advanced also by Bischoff,[3] as to the nature of the convolutions of the frontal lobe in the

[1] Memorie della R. Accad. delle Scienze di Torino, 1829, T. XXXV.
[2] Mémoire sur les plis cérébraux de l'Homme et des Primates.
[3] Beiträge zur Anatomie des Hylobates leuciscus, p. 78, München, 1870.

primates, if correct, has a physiological as well as a morphological significance when considered in connection with the localization by Broca and other observers of the centre of articulate language in the inferior or third frontal convolution. For if the centre of speech be localized in that convolution, in its absence, though the larynx and nerves involved be present, the nervous plexus being incomplete, speech becomes impossible. The parietal lobe anteriorly is separated from the frontal lobe by the central fissure, posteriorly from the occipital by the external and internal occipital fissures and laterally and inferiorly, at least in great part, from the temporal lobe by the posterior branch of the Sylvian fissure. The posterior central convolution, the most anterior portion of the parietal lobe, may be regarded as giving origin to the superior and inferior parietal lobules which, passing backward towards the occipital lobe, are separated by the parietal fissure, Pl. XI, fig. 2.

The parietal fissure begins above and a little beyond the middle of the posterior branch of the Sylvian fissure and passes upward and forward, then obliquely upward and backward, and having nearly reached the top of the hemisphere turns again and finally passes into the external occipital fissure. Of the three secondary fissures of the superior parietal lobule, the most noticeable is that upon the surface of the hemisphere, just posterior to the central fissure which resembles very much in its form the cruciform fissure of the orbital surface of the frontal lobe. Of the convolutions entering into the formation of the inferior parietal lobule we regard those surrounding the terminations of the Sylvian and superior temporal fissures as being the supramarginal and angular convolutions.

The mesial surface of the parietal lobe of our Gorilla was not as well preserved as the remaining parts of the brain, nevertheless that part of it lying between the ascending branch of the calloso-marginal and internal occipital fissures was identified as præcuneus. The occipital lobe, forming the posterior portion of the hemisphere, is separated from the parietal lobe mesially and internally by the internal occipital fissure, and externally and laterally by the external occipital fissure. There are, however, no distinct boundaries between the occipital lobe laterally and inferiorly and the parietal and temporal lobes, the occipital passing continuously into the latter lobes as the occipital and occipito-temporal convolutions. The internal and external occipital fissures in the brain of the Gorilla might be viewed when

taken together as corresponding to the parieto-occipital fissure in the brain of Man, supposing the latter to be broader and bridged over by the first occipital convolution. It appears to us, however, as more probable that the internal occipital fissure alone in the Gorilla should be regarded as homologous with the parieto-occipital fissure in Man, the external occipital fissure in the Gorilla corresponding to the fissure described in the brain of Man as the transverse occipital fissure. That the latter view is the correct one is still further shown by the fact already referred to of the parietal fissure passing into the transverse occipital fissure, which is often the case in Man. On the mesial, as well as upon the superior surface, the occipital is as distinctly separated from the parietal lobe by the parieto-occipital fissure in the brain of the Gorilla as in the brain of Man. It should be mentioned, however, that in the brain of the Gorilla the parieto-occipital does not reach the calcarine fissure, as is usually the case in the brain of Man, the two fissures being separated by a distinct convolution, the "deuxième plis de passage interne" of Gratiolet, the "untere immere Scheitelbogen windung" of Bischoff. That is, the part of the occipital lobe described in the brain of Man as the wedge-shaped convolution or cuneus is divided in the brain of the Gorilla into an upper and larger, and a lower and smaller portion. A similar disposition usually obtains in the brain of the anthropoids and the lower monkeys, though this convolution may be absent on one side at least, as was observed by the author[1] in the case of a Chimpanzee. On the other hand, it should be mentioned, as stated several years ago by the author[2] in a communication made to this Academy, that he had observed this convolution, that is, the "deuxième plis de passage interne" of Gratiolet, in the brain of Man, and he takes this opportunity of calling attention to its presence in the brain of the white man as well as in that of the negro.

The calcarine fissure in the brain of the Gorilla passed into the hippocampal fissure, the convolution of the hippocampus being thereby separated from the convolution of the corpus callosum. In this respect the brain of the Gorilla agrees with that of the remaining anthropoids and lower monkeys, in which the calcarine usually passes into the hippocampal fissure. In the brain of the Gorilla described by Broca, however, the calcarine did not reach the hippo-

[1] Proceedings A. N. S., Phila., 1879.

[2] Proceedings A. N. S., Phila., 1880.

campal fissure, the convolution of the hippocampus passing continuously into the convolution of the corpus callosum, a disposition sometimes observed in other anthropoids and monkeys, as in the Chimpanzee, Gibbon and Spider Monkey, and which, with few exceptions, obtains in Man. The first occipital convolution, already referred to as separating the parietal and occipital lobes, in winding around the transverse occipital and the parieto-occipital fissures, Pl. XII, fig. 3P, forms an arch convex inward, then convex outward, serving to connect the occipital with the parietal lobe, Pl. XII, fig. 3 p, and more especially with the supramarginal lobule of the latter. Hence the various names, annectant, bridging convolutions, premier plis de passage externe, obere immere Scheitelbogen windung, given to this convolution as well as that of first occipital convolution.

This bridging or arching convolution is well developed in both hemispheres of the brain of the Gorilla, that of the right hemisphere being slightly less superficial than that of the left. On neither side of the brain, Pl. XII, fig. 3, of the Gorilla can it be said, however, that there exists an operculum, so striking a feature in the brain of the Chimpanzee and of the lower monkeys. The second occipital convolution, lying behind the transverse occipital fissure and outside the first occipital convolution, passes into the parietal lobe and more particularly into the angular convolution of the latter. The third occipital convolution, better defined on the right side than on the left in the brain of our Gorilla, passes from the posterior extremity of the hemisphere into the second and third temporal convolutions, Pl. XI, fig. 2 u, v. Unfortunately the inferior surface of the occipital lobe of our specimen was too much altered to admit of exact description. Judging from what remains of it as compared with the corresponding part of the brains described by Bischoff and Broca, the lateral and median occipito-temporal convolutions must have been present and well defined. The temporal lobe, while distinctly separated from the frontal and parietal lobes by the Sylvian fissure, passes without defined boundaries, as just seen, into the occipital lobe and consists essentially of three convolutions. The superior temporal convolution, Pl. XI, fig. 2 t, lying between the fissure of Sylvius and the superior temporal fissure, passes obliquely upward and backward into the superior marginal convolution. The middle temporal convolution, lying between the superior temporal and

inferior temporal convolutions, passes partly into the angular convolution and partly into the occipital lobe. The inferior temporal convolution, Pl. XI, fig. 2V, lying below the inferior temporal fissure, passes into the occipital lobe. The fifth lobe, insula or island of Reil, lying between the frontal, parietal and temporal lobes, is but little developed in the brain of our Gorilla, much less so than in the brain of the Chimpanzee described by the author. The insula, while entirely covered by the operculum on the left hemisphere, is but partly so in the right. Unfortunately the hemispheres were so altered on the mesial surface in the hippocampal region as to render impossible the demonstration of the lateral ventricle with its hippocampus major and minor, etc. Inasmuch, however, as the parts in question were demonstrated by the author in the brains of the Orang and Chimpanzee, as had been done previously by others, doubtless they existed in the brain of our Gorilla. As to the remaining parts of the brain of the Gorilla the medulla and pons did not present any especially noticeable peculiarites. The cerebellum, Pl. XII, fig. 4, however, was not only absolutely but relatively smaller than that of Man or of the Chimpanzee or Orang, and was entirely covered by the cerebrum, the posterior or occipital lobes extending beyond the cerebellum to an extent of several millimetres, and this though the brain had been lying in alcohol for many months.

The cerebellum was entirely covered, as was also the case in the two other brains of the Gorilla already referred to as having been too much altered to admit of description. It was equally well covered in the brain of the adult Gorilla sent many years ago by the Rev. Mr. Nassau to Dr. Morton but which was unfortunately in such a condition in other respects as to render it unfit for description. It may be mentioned incidentally that the cerebellum of the Chimpanzee is larger than that of either the Gorilla or Orang, and it would appear that while it is entirely covered by the cerebrum in the adult or nearly adult animal, it is partly uncovered by the cerebrum in the young animal. At least of three Chimpanzees dissected by the author, in the two young animals it was demonstrated before the brain was taken out of the skull that the cerebellum was not covered by the cerebrum, and the same condition was observed in the brain of the young Chimpanzee dissected by Mr. Arthur E. Brown, Superintendent of the Philadelphia Zoological

Garden, as well as in those described by Bischoff,[1] Muller,[2] Giacomini.[3] In the third Chimpanzee, a nearly adult animal dissected by the author, the cerebellum was entirely covered by the cerebrum, and such was stated to be the case in the brain of the Chimpanzee described many years ago by Marshall.[4] Of eight Chimpanzee brains, in six the cerebellum was found uncovered by the cerebrum, in two covered.

In a previous communication addressed to the Academy[5] it was stated that no one anthropoid ape was more closely related to Man in the totality of its organization than another and that no anthropoid now known could be regarded as the ancestor of the other anthropoids, still less as the ancestor of Man, each anthropoid agreeing in some respects with related forms and with Man and differing from them in others. A comparison of the brain of the Gorilla with that of the Orang, Chimpanzee and Man confirms the conclusion then arrived at. While the fissures and convolutions are disposed as we have seen in the brain of the Gorilla in the same manner, generally speaking, as in that of Man or of the Chimpanzee or Orang, it is nevertheless a low type of brain, being much less convoluted than the brain of Man or of either of the two other anthropoids. It might be supposed that this was due to the fact of the brain just described being that of a young animal. That such, however, is not the case is shown by the two other brains of the Gorilla not being any more convoluted, though both of them were larger and heavier and from older animals.

The brain of the Gorilla further differs from that of Man or of the Chimpanzee or Orang in the markedly pointed shape of its frontal lobe, in the absence of the lower portion of the inferior or third frontal convolution, and in its orbital surface being so concave. With reference to this portion of the frontal lobe in the Gorilla it may be incidentally mentioned that the corresponding part in the brain of the Chimpanzee and especially in that of the Orang, presents the cruciform and orbital fissures disposed exactly as in Man, the orbital fissure being readily distinguished from the anterior branches of the Sylvian fissure. Had all these fissures been present in t brain of their Gorilla the interpretation of the orbital re

[1] Gehirn des Champanzee, 1871.
[2] Archiv fur Anthropologie, 1887.
[3] Atti della R. Accad. Torino, 1889.
[4] Natural History Review, 1861.
[5] Proc. Acad. Nat. Sciences Philad., 1880.

would not have given rise to the discussion between Pansch and Bischoff already referred to. On the other hand the Gorilla agrees with the Orang in the superficial disposition of the occipital convolutions, the operculum, so conspicuous a feature in the brain of the Chimpanzee, being absent. If it be permitted in the absence of living links or sufficient fossil remains to speculate upon the development of Man and the anthropoids from lower forms of simian life it might be inferred from the character of the brain that the Gorilla had descended from some extinct *Cynocephalus*; the Chimpanzee and Orang from extinct Macacque and Gibbon-like forms, and Man from some generalized simian form combining in itself the characteristics of existing anthropoids. The remote ancestors of such extinct forms, to recede still farther in geologic time, such as *Necrolemur* of Filhol, *Notharctus* of Leidy, *Limnotherium* of Marsh, *Anaptomorphus* of Cope, the latter the most simian Lemur yet discovered, resembled, as their names imply, the living Lemurs of the present day, intermediate forms connecting the extinct and existing genera having once lived but having now passed away. Notwithstanding the value and importance of the remains of Mesodonts, Prosimiæ and Lemurs discovered, especially by Leidy, Marsh and Cope, in the eocene formations of the Rocky Mountains, a much more complete series of simian remains than is now available must be placed at the disposal of the evolutionist before even a general outline of the geneology of Man and the remaining primates can be established.

ON THE ANATOMY OF SAGDA, CYSTICOPSIS, ÆGISTA AND DENTELLARIA.

BY HENRY A. PILSBRY.

Sagda (Hyalosagda) similis C. B. Adams. (Pl. XIII, figs. A. B. C. D. E.)

The specimens were collected by Mr. C. W. Johnson at Port Antonio, Jamaica, in April, 1891. They were killed by drowning.

The foot is very long and narrow, measuring length 20, breadth in the middle, 3 mm. The sides of the sole are subparallel. The sole (Pl. XIII, fig. E, *s.*) has a central longitudinal sulcus, but is not tripartite. Above, the foot is granulated.

The jaw (Pl. XIII, fig. D.) is delicate, thin and arcuate, having no median projection. It resembles somewhat the jaw of *Microphysa* and *Bulimulus*, seeming to be composed of twenty-seven narrow vertical plates, soldered together, but slightly overlapping on their outer edges. This shingle-like imbrication is not, however, as marked as in *Bulimulus*. The teeth resemble those of *Sagda haldemaniana* as figured by W. G. Binney, but they are shorter.

The genital system (Pl. XIII, figs. A. B. C.) is elongated. The female organs (fig. C.) lack dart sac or other accessory glands. The oviduct of the several specimens examined, contained from four to six ova, of a short-oval form, measuring 2·4 x 1·8 mm. The egg shell is hard, brittle and calcareous. The albumen gland (*a. gl.*) is narrow. The duct of the spermatheca (*sp.*) is very long, and is swollen at its origin. The male organs (figs. A. B.) are peculiar. The penis sac (*p.*) is long, and at its apex are inserted the vas deferens (*v. d.*), the retractor muscle (*r. p.*) and a long folded flagellum (*fl.*). From the middle of the penis sac springs a curiously complicated accessory diverticulum (figs. A. B., 2. *o.*). This organ is at first of equal size with the penis itself, but it then becomes very narrow; it again widens into a long, convoluted blind sac. In fig. A. this organ is seen in its natural position as it lies folded within the body-cavity. In fig. B. the organ is seen uncoiled to show its form and length. I do not know that any similar structure has been observed hitherto. The retractor muscle of the penis seemed to be attached to the vaginal sac, instead of to the body-wall. This may possibly be a mistake, however.

Cysticopsis tenerrima C. B. Adams. (Pl. XIII, fig. F.)

The single specimen which furnished the following details was taken by Mr. C. W. Johnson at Port Antonio, Jamaica, in April, 1891.

The animal is black externally. The foot is short; sole indistinctly tripartite.

The genitalia (Pl. XIII, fig. F.) are more like *Sagda* than any other form as yet known, and the group must evidently be removed from the vicinity of *Hemitrochus*, where it has hitherto been placed. The female system has the uterus enormously distended with young, which were twenty-seven in number in the specimen examined. The young shells are globular, consisting of two whorls; when dry they are very iridescent. Those in the upper part are less developed than the lower ones, and a single ovum, enclosed in a very thin, brittle white shell, was found. The spermatheca (*sp.*) has a long, bifurcating duct, closely bound to the oviduct, its extreme upper portion only being free. The penis sac (*p.*) is long, the vas deferens inserted near its summit. It terminates in two flagellate organs (*fl.*) the smaller being short and sickle-shaped. At the lower fourth of the penis-sac arises an organ comparable to the accessory organ in *Sagda similis*. This organ terminates in two long flagella (*x. x.*)

Aegista platyomphala Mlldff. (Pl. XIII, figs. G, H.)

A specimen containing the dried animal furnished the jaw and lingual membrane. The jaw (Pl. XIII, fig. H.) is rather strong, slightly arcuate, and furnished with five or six wide unequal ribs. These, with the exception of the one nearest the center, are low and not strongly defined. The cutting edge is weakly denticulated by the ribs. The superior-lateral portions of the jaw are thin.

The radula (Pl. XIII, fig. G.) is short and broad, consisting of 33-1-33 teeth. The rhachidian tooth (*r.*) and the inner ten laterals lack side cusps. The eleventh lateral develops a side cusp. There are fifteen or sixteen true lateral teeth. The inner marginal teeth become tricuspid by the bifurcation of the principal cusp; the outer marginals are quadricuspid, the side cusp also bifurcating.

The shell furnishing these preparations is No. 60,443 of the Academy collection. Collected by Mr. B. Schmacker. Locality, Kwangtung(Guangdung), China.

Caracolus (Dentellaria) orbiculata Fér. (Pl. XIII, fig. I, J.)

The specimens were collected in Martinique by l'Abbé Vathelet, and transmitted to me by post, alive.

The jaw of this species has been figured as smooth by Binney, but as that examined by me differs in having about seven low, unequal, rounded ribs, I have deemed it best to figure it for comparison (fig. J.). It is likely that there is considerable variation in this organ, some closely allied species having a strongly ribbed jaw, others a smooth jaw, as Binney has demonstrated.

The sole is indistinctly tripartite.

The genitalia are intermediate between those of *Lucerna* and *Caracolus* s. str. The penis has a short flagellate extension beyond the insertion of the vas deferens (fig. I, *fl.*). The spermatheca duct is long (*sp.*)

The genitalia of *Caracolus, Lucerna, Dentellaria* and *Thelidomus* have proved that the reference of all these large, opaque Helices of tropical America to a single genus (*Caracolus*) is a natural arrangement. The classification proposed by me in 1889[1], mainly upon conchologic characters, will therefore stand. It is safe to predict that the South American sections *Labyrinthus* and *Isomeria* will prove to be essentially similar to *Lucerna* and *Dentellaria* in anatomy.

Explanation of Plate XIII.

Fig. A. Genitalia of *Sagda similis*, showing the penis and the lower portion of the female system, *p.* penis; *r. p.* retractor muscle of the penis; *fl.* flagellum; *a. o.* accessory organ of the penis; *v. d.* vas deferens.

Fig. B. View of the lower portion of the penis with its accessory organ, the latter partially pinned out. Lettering as in fig. A.

Fig. C. Female genital organs of *Sagda similis*. At *o.* are seen eggs in the oviduct.

Fig. D. Jaw of *Sagda similis*.

Fig. E. Foot of *Sagda similis*. *t.* tail, showing granulation, *s.* sole showing the median furrow.

Fig. F. Genital system of *Cysticopsis tenerrima* Ad. *p.* penis; *fl.* flagellum; *r. p.* retractor muscle; *v. d.* vas deferens *x. x.* flagellate extensions of the accessory organ of penis; *g. cl.* genital cloaca; *sp.* spermatheca; *a. gl.* albumen gland; *h. d.* hermaphrodite duct.

Fig. G. Teeth of *Aegista platyomphala* Mlldff.

Fig. H. Jaw of *Aegista platyomphala* Mlldff.

Fig. I. Genitalia of *Dentellaria orbiculata* Fér. Lettering as in Fig. F.

Fig. J. Jaw of *Dentellaria orbiculata* Fér.

[1] Manual of Conchology, 2d Series, V, p. 75, 76.

MAY 3.

The President, GENERAL ISAAC J. WISTAR, in the chair.

Forty-six persons present.

IN MEMORY OF DR. SERENO WATSON—The following resolutions were received from the Botanical Section and unanimously adopted:—

Whereas—The Botanical Section of the Academy of Natural Sciences of Philadelphia has learned with profound regret of the death of Dr. Sereno Watson of Cambridge, Mass., and desirous of placing on record its sense of this great loss, in consequence of which botanical science througout the world suffers, therefore.

Resolved.—That we recognize his invaluable services in the dissemination of a knowledge of American botany, a work to which he had given his undivided attention for many years and which has rendered his name famous wherever the study of plants and plant life has been cultivated.

Resolved.—That a copy of this minute be forwarded to the President of Harvard University and to the Gray Herbarium at Harvard with which he was so long associated, and that the same he offered for publication in the Proceedings of this Academy.

MAY 10.

The President, GENERAL ISAAC J. WISTAR, in the chair.

Forty-two persons present.

The deaths of D. B. Cummins, a member, and of Dr. C. A. Dohrn, a correspondent, were announced.

MAY 17.

The President, GENERAL ISAAC J. WISTAR, in the chair.

Forty-three persons present.

MAY 24.

The President, GENERAL ISAAC J. WISTAR, in the chair.

Forty-three persons present.

On the Cephalo-humeral Muscle and the so-called rudimental Clavicle of Carnivora.—DR. HARRISON ALLEN spoke of some of the peculiarities of the cephalo-humeral muscle in mammals and invited especial attention to the presence of a small fibro-cartilaginous disc in the junction of the cephalo-humeral with the muscles which are inserted in the bones at the region of the shoulder. This is well defined in *Felis* and is identified as a rudimental clavicle. Dr. Allen had detected this structure in *Herpestis, Taxidea, Cercoleptes, Bassaris* and *Procyon*.

The cartilage is either in the form of a flat disc or a minute scythe-shaped rod, and is constant in lying directly over the greatest convexity formed by the round of the shoulder. It seems to give strength to the centre of a muscle-system of which the cephalic, cervical, pectoral and latissimal sheets are parts. The identification of such a plate or rod with a true clavicle is doubtful since in *Balantiopteryx* (a genus of bats) the structure above described is remarkably developed while the clavicle is as well formed as in any other animal. The long rod-like body is continuous with a fascicle of fibres arising from the pectoralis and receives the insertion of the occipito-pollicalis. The anterior end of the rod lies in the upper border of the wing membrane and is continuous with the fibrous thread which represents the tendon of the occipito-pollicalis as this muscle is defined in the bats generally. From both the proximal and distal divisions of this muscle delicate fascicles pass toward the elbow and the entire plan appears to be associated with the rudiment of the characteristic skin sac. Slight modification of this arrangement is met with in the allied genus *Rhynchonycteris*.

Comparison of this arrangement with that seen in the common brown bat (*Adelonycteris fuscus*), the noctula bat (*Noctulinia noctula*), and the false vampire (*Vampyrus spectrum*) showed that the part taken by the rod in *Balantiopteryx* is the tendon of a pectoral muscle-fascicle which is inserted into the occipito-pollical muscle as it crosses the shoulder, while in the group of the Molossi the muscle-fascicle is fleshy throughout its entire extent, but on the whole preserving the same relations. Thus the fibro-cartilage of *Balanteopteryx* is represented by fibrous tissue in *Adelonycteris* and both these in turn by muscle in the Molossi. Dr. Allen believed that it was inexact to speak of a clavicle and of this rod as things which were equal. The clavicle acts with the scapula in supporting the head of the humerus but in no wise limiting or determining its movements, while the rod is always over the outer aspect of the shaft of the humerus below its head and here acts as a check to abduction of this bone.

MAY 31.

Mr. CHARLES MORRIS in the chair.

Twenty-nine members present.

A paper entitled "A Catalogue of the Fishes of Greece, with notes on the Vernacular Names now in use and those employed by Classical Authors," by Horace Addison Hoffman, assisted by David Starr Jordan, was presented for publication.

Henry Redmond, M. D. and J. F. Sachse were elected members.

Edw. J. Miers, of London, was elected a correspondent.

ON THE MECHANICAL GENESIS OF THE SCALES OF FISHES.

BY JOHN A. RYDER.

Fourteen years ago the present writer suggested that the slow metamorphosis of the forms of the crowns of the teeth of mammalia,[1] in the course of a vast number of successive generations, might be ascribed to the continuous, slow and cumulative action of mechanical strains and pressures in definite directions, resulting in the production of permanent stresses and consequent changes in the forms of the crowns, especially of the molar series. The evidence since accumulated from vertebrate palæontology and anatomy has served to strengthen the belief that such an hypothesis cannot be dismissed as useless until a better one has been offered in its stead. The present paper is an attempt to apply somewhat analogous reasoning to a somewhat simpler, but no less interesting, problem in morphogenesis.

The mechanical hypothesis now to be offered respecting the genesis of the scales of fishes, accounts for the origin of such scales from a continuous subepidermal matrix, which may be regarded as a basement membrane. Such a matrix is found to actually exist in some forms, at an early stage, just beneath the epidermis. It is thickest on the dorsal and lateral aspects of the body as is seen in sections of the young of the scaleless *Batrachus tau*, for example. Such a matrix also exists in the larval stages of other scale-bearing forms and may be continuous with the very attenuated basement membrane from which the actinotrichia or primordial fin-rays of embryo fishes seem to be in part differentiated. Such a matrix is almost co-extensive with the whole epidermal layer of the young of many types of fishes, just at the time when the scales commence to be developed.

The hypothesis further accounts for the arrangement of the scales in longitudinal and in oblique rows in two directions. The oblique rows are arranged, as is well-known, in a direction from above downward and backward and also in the reverse direction from below upward and backward. That is, the scales may be counted in rows in three directions downward and forward as well as down-

[1] On the Mechanical Genesis of Tooth-forms. Proc. Acad. Nat. Sciences, 1878.

ward and backward, and, starting from any scale in any oblique row, they may be counted either forward or backward longitudinally or in conformity with the direction of the axis of the body of the fish. This is conspicuously the case in Clupeoids and some Cyprinoids.

In such archaic types as these, approximating the primitive isospondylous condition, it is also found that the number of scales in a longitudinal row corresponds, on the sides of the body, very exactly with the number of muscle-plates or somites of the body. It is also found that the myocommata or sheets of connective tissue intervening between the successive somites are attached with great firmness to the deeper layers of the skin or corium. Such a construction, together with the peculiar arrangement of the muscle plates at the time the scales begin to develop conditions the further growth of the scale matrix. This is affected in such a manner that the whole of the integument is thrown into definitely circumscribed areolæ, during the ordinary movements of the fish in swimming. The central portions of each of these areolæ are left in a quiescent condition while their margins are wrinkled or folded as a result of the current action of the lateral muscles of the body. In this wise each and every one of the dermal and epidermal areolæ are circumscribed by the action of the fish in the normal act of swimming. In each of the circumscribed areolæ a scale develops; the continuity of its development with its fellows across the margins of the areola is prevented by the continual bendings or flexures to which the dermis is there subjected owing to the action of the muscles.

This will be better understood by referring to the accompanying diagram representing the arrangement of the muscular somites of a Cyprinoid (*Carassius*) with their intervening myocommata as seen from the side when the skin with its scales is removed. Before proceeding further, however, it may be well to insist upon the fact that the rows of scales are found to conform to the successive somites. This is of itself significant. The careful interpretation of the facts from observation, however, discloses a very remarkable effect due to the peculiar arrangement of the muscle plates.

As is well known the muscular masses of the sides of the body of a fish are arranged in the form of two longitudinal trihedral columns separated along the middle line of the side *a* to *b* into a dorsal and ventral half. The somites entering into the composition of these ventral and dorsal masses were at first absolutely continuous across

the longitudinal, horizontal septum *a*, *b*. If we suppose the somites of the adult as developed from a continuous embryonic segment extending the whole depth of the body, then will somites I, II, III, IV, V etc., in the figure form two parallel series of muscular blocks above and below the line *a*, *b*. Each half somite is also seen to present an acute apex directed backward at the points *c* and *c'* above and below the line *a*, *b*. The somites I, II, III, IV and V are therefore sigmoid in outline as seen from the exterior. The myocommata or connective tissue septa 1, 2, 3, 4, 5, 6 etc., which intervene between the somites, have a corresponding sigmoid arrangement. The sigmoid or ≷-shaped myocommata and the myotomes, are reciprocally coadapted to each other in configuration like a nest of ≷≷≷≷≷'s turned upon their sides. If we further supposed that thin and thick-legged ≷'s alternated thus ≷≷≷≷≷≷≷ we might suppose the thin-legged ones to represent the myocommata and the thick-legged ones the muscle plates or myotomes. The muscular fibres of the thick-legged ≷'s run longitudinally from the posterior surface of the myocomma immediately in front of it, to be inserted into the anterior face of the myocomma immediately behind it. The muscular tension is therefore exerted upon the opposite sides of the myocommata and is thus propagated along the sides of the body from the head to the tail, from the first to the last myotome. But the tension upon the inner face of the skin is along the lines of insertion of the myocommata 1 *c'c*, 2 *c'c*, 3 *c'c*, etc., this will serve to wrinkle the skin not only along the lines 1 *c'c* 2 *c'c*, etc., but also to cause wrinkles to appear along the dotted lines, *d*, *d'*, *e* and *e'*. In this way it is easy to see that the whole lateral integument will be thrown into definitely circumscribed rhomboidal areolæ in which separate overlapping scales *s*, *s*, *s*, *s*, may appear. The wrinkles thus produced by the

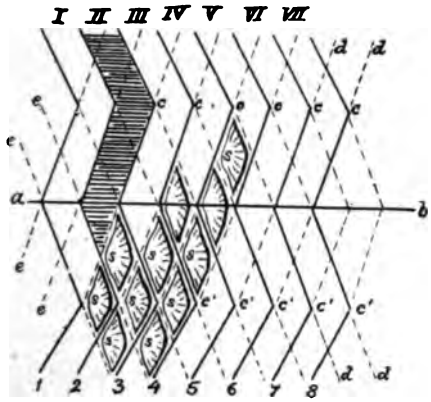


FIG. 1.

tension of myocommata upon the integuments of the body will cross each other and be reinforced at six points in the zigzag transverse course of each myocomma, viz., twice at each of the points *c* and *c'* and along the line *a*, *b*, where the middle limb of the ≷ rests.

The only point which now remains to be discussed is the imbrication of the scales. This is also as readily accounted for as the delimitation of the scale-forming areolæ, *s*, *s*, *s*, and their tri-linear arrangement in three directions in the convex surface of the integument by means of the mechanical hypothesis here outlined. If we

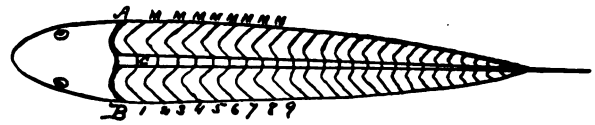


FIG. 2.

were to make a longitudinal transverse section through a fish along the plane of the letters *c*, *c*, *c*, or *c' c' c'* of Fig. 1, we should get a section like Fig. 2 in which the myotomes M, M, M, etc., Fig. 2 were again found to be V-shaped on either side of the medial axis or vertebral column *c*, *c*, Fig. 2. This proves that the myotomes are really cones fitting into one another and that if we suppose the first one to be inserted into the base of the skull along the line *A*, *B*, Fig. 2, that point becomes the anterior fulcrum or *point d'appui* of the whole muscular system. The tensions thus developed upon the skin along the successive myocommata 1, 2, 3 etc., Fig. 2, is such that the integument would be flexed inward opposite each myocomma as shown in the next figure, on a larger scale, which represents the foldings of the integument at the surface of a part of Fig. 2. Here in Fig. 3, the myocommata *m*, *i'*, *m*, *i'*, *m*, etc. are seen to be inserted upon the internal face of the epidermis *ep*, *ep*. The membrane *m*, *m*, *m*, *m*, acted upon by the muscular fibres of the myotomes M, M, M, will have the effect of pulling the integument inward in the direction of the arrows *i'*, *i'*, from the linear points of attachment of the myocommata to the inte-

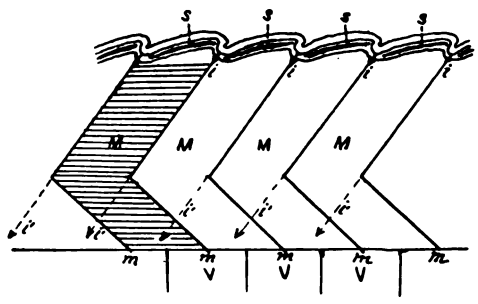


FIG. 3.

guments at *i*, *i*, *i*, toward the vertebral bodies V, V, V. In this manner will be developed the imbrication indicated by the heavy border along the posterior margins of the scales *s*, *s*, *s*, in Fig. 1, and in Fig. 3, in longitudinal section through the scale sacks or pockets at *s*, *s*, *s*.

It will be clear that in the case considered the arrangement and imbrication of the scales is determined by the actions of the segmentally arranged muscles of the body. In other words, whatever has determined the development of somites has also, in the most clear and direct manner, determined the segmentally recurrent and peculiar tri-linear and imbricated arrangement of the scales of many fishes. It may be urged in objection that heredity has determined the number, arrangement and the development of the somites and, therefore, the development of the scales is also a sequence of hereditary influences working thus indirectly. This view of the case may be admitted without invalidating the conclusion that, given the growing mechanism here described, the development of the scales would under any circumstances have been interfered with at the points where the integument was being continually flexed, wrinkled or folded as it is around the integumentary areolæ wherein the scales are formed, as has been here proved to correspond with the facts.

Special types of squamation amongst fishes may require an interpretation different as to details from the foregoing, but it is probable that such special cases will rather tend to confirm than otherwise the views developed in this sketch of an hypothesis respecting the mechanical origin of the arrangement and imbrication of the scales of fishes. For example, one of the most extreme cases, that of the sturgeon, shows that the smaller integumentary plates between the large dorsal, lateral and ventral rows, conform to these lines of tension of the myocommata upon the integument. An even more instructive example is that of the common eel in which the scales are oblong rhombs or parallelograms, arranged with their diameters in oblique lines, running in two directions conformably with the tensions, wrinklings and foldings of the integuments produced by the oblique insertions of the muscles when the latter are brought into action. Other cases where the scales are very fine might be urged in objection, especially where several oblique rows of scales are found to correspond to each somite. Such parallel duplication of scale rows, however, does not invalidate the principle since the rows

still conform to the lines of tension of the linear attachment of the myocommata to the integuments. The hypothesis may also be extended so as to consistently consider such forms as the pipe-fishes and other anomalous forms, where sluggish habits coupled with the almost exclusive use of the dorsal fin in swimming, has rendered the lateral musculature of the body comparatively subordinate in function, and which may even lead to secondary fusion of somites and the consolidation of consecutive pairs or triplets of vertebral centra into single vertebral bodies.

Two conclusions of prime importance may be drawn from the hypothesis and the evidence here presented, namely:

1. The scales of fishes bear a segmental relation to the remaining hard and soft parts, and are either repeated consecutively and in oblique rows corresponding to the number of segments, or they may be repeated in rows as multiples of the somites, or segmental reduction may occur which may affect the arrangement of the scales so as to reduce the number of rows below the number of somites indicated by the other soft and hard parts.

2. The peculiar manner of interdigitation of the muscular somites, as indicated by the sigmoid outline of the myocommata, as seen from their outer faces, and the oblique direction of the membranes separating the muscular cones, has developed a mode of insertion of the myocommata upon the corium which has thrown the integument into rhombic areolæ during muscular contraction. These areolæ are in line in three directions and the folds separating them, particularly at their posterior borders, are inflected in such a manner by muscular tensions, due to the arrangement of muscular cones, as to induce the condition of imbrication so characteristic of the squamation of many fishes.

JUNE 7.

Mr. JOHN H. REDFIELD in the chair.

Thirty-nine persons present.

The death of H. F. Formad, M. D., a member, was announced.

JUNE 14.

Mr. CHARLES MORRIS in the chair

Thirty-five persons present.

A communication from Edw. D. Cope on the fauna of the Blanco Beds of Texas was read and referred to the Publication Committee as a paper under the provisional title "The Fauna of the Blanco Beds of Texas."

JUNE 21.

Mr. USELMA C. SMITH in the chair.

Thirty-one persons present.

JUNE 28.

Dr. GEO. H. HORN in the chair.

Twenty-four persons present.

The following were elected members:—

J. Hunter Ewing, C. A. Hamann, M. D., Henry Whelen and Francis M. Brooke.

The following were ordered to be printed:—

A CONTRIBUTION TO A KNOWLEDGE OF THE FAUNA OF THE BLANCO BEDS OF TEXAS.

BY EDW. D. COPE.

Prof. E. T. Dumble, State Geologist of Texas, appointed Prof. W. F. Cummins to conduct the survey of the northwestern district of the state, and in pursuance of this order the latter gentleman is now examining the mesozoic and cenozoic beds which compose and underlie the Staked Plains. I accompanied this party in the capacity of paleontologist, having already determined the vertebrate fossils collected by the Survey's expeditions of last year (see Proceedings of the American Philosophical Society, first No. for 1892).

The superficial formation of the Staked Plains has been determined by Prof. R. T. Hill to be of late cenozoic age, and the term Blanco beds has been applied to it by Prof. Cummins. The examination of the vertebrate fossils from it led me to state (*loc. cit.*) that in age the Blanco formation intervenes between the Loup Fork below and the Equus bed above, in the series. This conclusion was based chiefly on the fact of the presence of horses of the genus *Equus* (*E. simplicidens* Cope) in association with mastodons of the molar dental type of the *Tetrabelodon angustidens*, an association not previously met with in North America. In addition to these species, the presence of a peculiar land tortoise (*Testudo turgida* Cope), and of a new genus of birds allied to the rails (*Crecoides* Shuf.) was established.

I propose to present to the Academy, a list of the species obtained, so far, from the Blanco beds by the present expedition, with such conclusions as may be derived from it.

TESTUDINATA.

Testudo turgida Cope, loc. cit.
Testudo pertenuis, sp. nov.

Founded on a large specimen measuring three and a half feet in length by three in width, and remarkable for the transverse width of the vertebral dermal scuta. The carapace is rather flat and descends steeply posteriorly, the anal marginal bone being somewhat incurved. Margins of carapace flare outwards above the legs. The plastron has a rather wide lip, with flat base, and straight lateral borders; its anterior border is lost. The posterior lobe is deeply

and widely notched, terminating on each side in a subequilateral angular prominence. Both carapace and plastron are without sculpture, the posterior angles of the plastron only being longitudinally grooved below. The vertebral scuta are considerably wider than long, as is also the anal scutum. Both carapace and plastron are very thin, not exceeding one-quarter inch. in the specimen described, except at the borders. Measurements: Length over all 4·2 feet; width over all 4 feet; width of penultimate dorsal scute 1·275 feet, length ·85 feet; width of last vertebral scute 1·35 feet; width of anal scute 1·5 feet, length ·6 feet. Length of penultimate costal scute ·9 feet; length of last costal ·95 feet. Width of lip of plastron at base ·8 feet; width of anterior lobe at axillæ 2 feet. Width of posterior lobe of plastron at base 2 feet; width at fundus of median notch 1·1 feet; width at apices of angular processes ·85 feet; depth of notch ·5 feet. This is the largest species of land tortoise yet known from North America.

EDENTATA.

Megalonyx, sp.

Teeth and fragments of skull.

CARNIVORA.

A canid and three undetermined forms represent the Carnivora.

PROBOSCIDIA.

Mastodon successor, sp. nov.

This species is represented by teeth in collections previously made by Prof. Cummins, and though the characters of these resemble closely those of the *Tetrabelodon angustidens*, I did not identify them as pertaining to that species. From its association with the genus *Equus*, I suspected that it would prove to be distinct from the latter; and the accession of more material proves this to be the case. It is a species of the genus *Mastodon* and not of *Tetrabelodon*, having a very short, contracted and elephant-like symphysis. The most complete specimen is represented by both rami of the lower jaw with symphysis complete, but lacking angles and condyles; accompanied by a tusk of the upper jaw. The latter is without enamel band. The second true molars are in place, showing their patterns, and the third molars have only three crests protruded. Besides

the subsidiary tubercles which form the trefoils of the inner side of the molars there are a few other tubercles closing the valleys. The second true molars have a narrow fourth cross-crest. Measurements: Length of left ramus preserved 2.55 feet; length from anterior base of coronoid process to apex of snout 1·55 feet; length of second true molar ·45 feet; width between second molars ·35 feet; total width of rami at middle of M. 3–1·4 feet; width of crown of M. 3 at front crest ·35 feet; diameter of tusk near middle ·625 feet. This species is nearest to the *Mastodon andium* Laurill., but that species, according to Burmeister, has an elongate symphysis, although without tusks.

Mastodon cfr. **mirificus** Leidy.

Rather common.

Mastodon cfr. **shepardii** Leidy.

One molar obtained.

PERISSODACTYLA.

Equus simplicidens Cope, l. c.

The most abundant mammal and retaining exactly the characters of the molar teeth as originally defined.

Equus, sp.

Smaller and with plicate enamel.

Equus, sp.

Much smaller than the last, and quite rare; not determined.

ARTIODACTYLA.

Pliauchenia.

A large species about the size of the existing camel is abundant; not determined. *Pliauchenia* bones of a species larger than the last may be referable to this genus. Small Artiodactyla not determined.

Of the preceding list of fifteen species it may be remarked that *Megalonyx* and *Equus* are not Loup Fork genera, while *Mastodon* and *Pliauchenia* are such. No species is found in the Loup Fork bed. On the other hand, *Megalonyx* and *Equus* are Equus-bed genera, while *Pliauchenia* and *Mastodon* have not been found in them, although it is probable that the latter existed. No species is found in that horizon. The conclusion is inevitable that the fauna of the Blanco bed is intermediate between the two mentioned, and that it fills an

important gap in geologic and paleontologic history. It was a fauna including species of large size, the relative abundance of mastodons, camels and horses being especially noteworthy. The fact that no trace of rhinoceros has been found is remarkable.

A CATALOGUE OF THE FISHES OF GREECE, WITH NOTES ON THE NAMES NOW IN USE AND THOSE EMPLOYED BY CLASSICAL AUTHORS.

BY HORACE ADDISON HOFFMAN AND DAVID STARR JORDAN.

The first-named author of the present paper spent a large part of the spring and summer of 1890 in Greece. Part of this time was devoted to making collections of the fishes found in the markets of Athens and to the study of the vernacular names now applied by the Greek fishermen to these fishes. Each fish as obtained was preserved in alcohol, a number attached to it, and a record kept of the vernacular name attached to this number.

The persistence of vernacular names of fishes and other animals is known to be very great, and it may be safely assumed that the most of these names now heard in Athens are derived from those applied to the same species in the time of Aristotle. It has been thought that a study of these names would tend to throw light on those applied to fishes by classical authors. The fact that no such collection or comparison of names of fishes has yet been made is the justification of this paper.

A single catalogue of the fishes of Greece is known to me, that published by my friend, Professor Apostolides in 1883 (La Pêche en Grèce: par Nicolas Chr. Apostolidès). This work contains numerous vernacular names and it has been largely drawn upon in the present paper.

In this paper is printed a systematic list of the fishes known from Greece, either on the authority of Apostolides or from my own collection, with the vernacular names and such notes on them as I am able to offer.

No one can be more fully aware than I am, of the unsatisfactory character of many things in this paper. It was often difficult or impossible to make out with certainty just what Aristotle meant. Some terms occurring over and over and evidently having a very definite meaning to him are obscure to us, and the meanings given in the dictionaries are only guesses. A good illustration of this is the word ὑπόζωμα, usually translated diaphragm. We have no right to assume that Aristotle always, or ever, meant by this term the diaphragm, especially in those instances where it makes him entirely wrong in regard to the anatomical facts. In those matters

which could be seen by dissection I feel convinced that Aristotle made the dissections for himself and reported what he saw. He may not always have seen aright in nice points, and he certainly did not understand what he saw as it is understood in the light of modern science; but there is no ground for assuming that he did not see what would be apparent to any one who took the least pains to look, even if with unpractised eye. A striking confirmation of the correctness of his observation in matters of anatomy was afforded by the repeated statement that the βάτραχος (*Lophius piscatorius*) has its gall bladder upon the intestine, not upon the liver. A dissection of this fish by Dr. Charles H. Gilbert proved the statement of Aristotle to be correct. I believe that a reading of Aristotle in the original accompanied by dissections of the animals in question would bring one to a much better understanding of his anatomical terms, which are much in need of some such elucidation.

It is quite otherwise when he comes to the habits of the fishes and other matters than anatomical knowledge. Here he has to depend upon the observations of the fishermen and others, and what he has to say simply records the prevalent beliefs. Of course much of this fisherman's lore is real knowledge gained from observation, but it has also a considerable share of myth.

Another great source of difficulty is corruption of the text. Considering all the time and the vicissitudes that the Mss. of Aristotle have passed through it is always more or less problematical as to whether in any given passage we have just what Aristotle said.

For the nomenclature and systematic arrangement of the species, the identification of my specimens, and for all matters purely zoological in character I am indebted to Dr. David S. Jordan, at whose suggestion the work was undertaken. The specimens obtained are in the museum of the University of Indiana.

Explanatory Notes.

1. The following order of statement has been adopted: (1) Scientific name by Dr. Jordan. (2) M. G. (Modern Greek) na or names heard by me in Greece, if any; each name followed immedi by a small figure in parenthesis indicating the number of sp secured under that name. (3) A reference to the page of A lides' book (La Pêche en Grèce par Nicolas Chr. Apostoli ens, 1883), where the species is given, followed by the

name used by him, and the vernacular name or names given by him. (4) The similar name or names from A. G. (Ancient Greek) authors, chiefly Aristotle, references to the places in their works where these names are found, and a gathering up of the chief things said about the fish in question, especially anything which might in any way help to fix the identity of the species.

Explanatory remarks and comments are thrown in wherever in each case it seems most suitable.

2. Modern Greek names marked with an asterisk (*) were heard by me in the market at Athens, sometimes elsewhere in Greece, but do not occur in Apostolides' list.

3. Names marked with a dagger (†) occur in Apostolides, but were not heard by me in Greece.

4. Names not marked by any sign were both heard by me and found in Apostolides. They are not marked if the variations in form are slight and insignificant, even if the forms are not identical.

5. When the names are derived from other sources the source is given in connection with the name.

6. The references to Aristotle are taken from the Index Aristotelicus of Hermann Bonitz, and, as there, refer to the page, column and line of the quarto edition of Aristotle's works issued by the Royal Academy of Prussia through Georg Reimer, Berlin.

The references to Athenaeus, mostly from the VIIth book, are given by book and section, Editio C. Tauchnitii, Otto Holtze, Leipzig, 1887.

7. Species obtained by me in Greece are marked H. The list which follows is that of Apostolides, the species arranged in accordance with the views of American authors and the accepted rules of nomenclature applied to their names.

Family **BRANCHIOSTOMATIDÆ.**

1. Branchiostoma lanceolatum (Pallas).

Apost. 35 (*Branchiostoma lanceola* or *Amphioxus lanceolatus*)

Family **PETROMYZONTIDÆ.**

2. Petromyzon marinus (L).

Apost. 34 (*Petromyzon marinus*), † λάμπρινα, Lat. *lampetra*, rock-sucker, Eng. lamprey; λάμπρινα is evidently of Latin and Italian origin.

Family **SCYLLIORHINIDÆ.**

3. Scylliorhinus canicula (L).

Apost. 5 (*Scyllium canicula*), † *σκυλί*, † *σκυλόψαρο*, dog, dog-fish. A. G. *σκύλαξ*, whelp, pup, dog. M. G. *σκυλί(ον)*, dog. Aristotle, *σκυλίων*, name of a fish, 565a 16–26; 566a 19.

According to Aristotle the ova of the *σκυλίων* are grown fast between the branches of the oviduct about the backbone; as these ova increase in size they change their position and move around into one or the other branch of the oviduct, which is forked and grown fast to the *ὑπόζωμα* (diaphragm, peritoneum) just as in other similar fishes. The oviduct of both this and the other Galeodes has at a little distance from the *ὑπόζωμα* a kind of white breasts (oviducal glands) which are not present when they are not pregnant. The shells of their eggs are shaped like the tongues (reeds) of pipes (*αὐλοί*), and there are attached to them hair-like ducts. The other *γαλεοί* breed twice a year, but the *σκυλίων* only once.

4. Catulus stellaris (L).

Apost. 5, 6 (*Scyllium catulus*), † *γάτος* = *κάτος*, cat. Byzantine and Roman times, *κάττα*, *κάττος*; Latin, *catta*, Martial 13, 69.

I find no ancient application of this name to a fish.

Family **ALOPIIDÆ.**

5. Alopias vulpes (Gmelin).

Apost. 6, † *σκυλόψαρο*.

Family **CARCHARIIDÆ.**

6. Carcharias ferox (Risso).

Apost. 6. (*Odontaspis ferox.*)

Family **LAMNIDÆ.**

7. Lamna cornubica (Gmelin).

Apost. 6, † *σκυλόψαρο*.

8. Isurus oxyrhynchus (Rafinesque).

Apost. 6 (*Oxyrhina spallanzani*), † *σκυλόψαρο*.

9. Carcharodon carcharias (L).

Apost. 6 (*Carcharodon lamia*), † *καρχαρίας*, † *λάμια*. See Athen. vii, 76. Athenaeus quotes several passages from ancient authors where the name *καρχαρίας* occurs, and among them the following from Nicandrus the Colophonian in his "Glosses:" "The *καρχαρίας* is called also *λάμια* and *σκύλλα*."

The word *καρχαρίας* itself is from *κάρχαρος*, sharp, or sharp-toothed. The *Lamia* and *Scylla* were fierce man-devouring monsters of Greek myth.

Family **GALEORHINIDÆ.**

10. Galeus canis (Mitchell).

Apost. 7. (*Mustelus vulgaris.*)

11. Galeus mustelus (L).

Apost. 7. (*Mustelus lævis*) *γαλητός*.

12. Carcharhinus glaucus (L).

Apost. 7. (*Carcharias glaucus.*)

Family **SPHYRNIDÆ.**

13. Sphyrna zygæna (L).

Apost. 7 (*Zygæna malleus*), † *ζύγαινα*. Mentioned by Arist. 506b 10 among long fishes with the gall on the liver. Also mentioned by Epicharmus, Frag. 30.

I saw some fishermen catch a hammer-headed shark in the Bay of Eleusis, but all the names I could elicit were *κανῆκι* (?) possibly *κυνίκι* = little dog, and *ἀγριόψαρο* = fierce fish.

14. Sphyrna tudes (Cuvier).

Apost. 7 (*Zygæna tudes*), † *πατερίτσα*, crutch, bishop's staff.

Family **HEXANCHIDÆ.**

15. Heptranchias cinereus (Gmelin).

Apost. 7. (*Heptanchus cinereus.*)

Family **SQUALIDÆ**

16. Squalus acanthias (L).

Apost. 8. (*Acanthias vulgaris*) † *σκυλόψαρο*.

17. Squalus blainvillei (Risso). H. *Γαλεό(ς)* (1).

Not noticed by Apostolides. Apost. 7 gives *γαλητός* as common name for *Mustelus lævis*. *Γαλεός*, *γαλεοειδής* and *γαλεώδης* all occur quite frequently in Aristotle. 505a 15, 489b 5 and 6, 511a 4–6, 1529a 29, 621b 16, 565b 28, 543a 17, 566a 17, 565a 26, 754b 33, 565b 2ff, 508b 17 (Here *γαλῆ* is probably the proper reading, M. G. *γάλια*, *Lota fluviatalis*. Cf. Aelian xv, 11, Bonitz.), 565a 20, 566a 31, 565a 14, 540b 19, 505a 18, 505a 5, 506b 8, 507a 15, 540b 27.

According to Aristotle the *γαλεοί* are the long *σελάχη* with uncovered gills on their sides (sharks), as distinguished from the flat *σελάχη* with uncovered gills underneath them (rays). The *γαλεοί* are ovoviviparous, produce at the most three young at a time, and admit their offspring

into themselves (into their mouths) and let them out again. The ποικίλος and ἀλωπεκίας do this especially, but others do not because of their roughness. The γαλεοί have a mouth opening wide (literally 'breaking back'). The ἀκανθίας (thorny) γαλεός has its ova attached to the ὑπόζωμα (peritoneum [?]) above the oviducal glands, and when the ovum descends upon its having been loosed the young fish is produced. In the same way generation takes place in the ἀλώπηξ. But the so-called smooth γαλεοί have their ova between the branches of the oviduct like the σκυλίων. The ova moving about descend into one or the other branch of the oviduct and the young are produced, having the umbilical cord attached to the oviduct, so that when the eggs are used up these fish seem to have an embryo just like the quadrupeds. In the case of the σκυλία, which some call νεβρίαι γαλεοί (i. e. γαλεοί dappled like a fawn, fawn-colored sharks), when the shell of the egg bursts and falls off the young fish is born. There are several kinds of γαλεοί, e. g. ἀστερίας, κεντρίνης, ἀκανθίας, λεῖος, ποικίλος, σκύμνος, ἀλωπεκίας. See Athen. vii, 43.

In 508b 17 γαλεοί are mentioned among fishes which have many pyloric appendages, but this is thought to be a corrupted reading for γαλῆ. See above under references.

The γαλεοί and γαλεοειδεῖς, as ἀλώπηξ and κύων, and the flat fishes, νάρκη, βάτος, λειόβατος and τρυγών produce their young alive, having first produced eggs internally. The form of the uterus (oviduct) must be seen from dissections. The γαλεώδη have it different from one another and from the flat σελάχη. For in some cases the ova are grown fast around the back bone between the branches of the uterus (oviduct, ὑστέρα), just as has been said in the case of the σκυλίων. As the ova increase in size they move around. The uterus being forked and grown to the ὑπόζωμα (diaphragm, peritoneum) just as that of others of this kind, the ova come around into one or the other branch of the uterus (oviduct). Both the uterus of this and that of the other γαλεοειδεῖς at a little distance from the ὑπόζωμα have what resembles white breasts (oviducal glands) which are not present when they are not pregnant.

The γαλεώδεις all have their gills double and five on each side. They also have the gall bladder on the liver, and the two parts of the liver are independent, the beginning not being grown together. The males differ from the females by having two appendages hanging about the vent.

18. Oxynotus centrina.

Apost. 8 (*Centrina vulpecula*), *γουρουνόψαρο*.

The word is M. G. and means hog-fish. So A. G. *χοῖρος*, hog, was used as name of a fish found in the Nile. Strabo 823, Athen. 312 A. (vii, 88).

I saw the *γουρουνόψαρο* in the market at Athens and heard the name from the market men, but the specimen was too large to be preserved.

Family **SQUATINIDÆ.**

19. Squatina squatina H. * *ῥίνα* (1), * *συρσύλλα* (1).

Not noticed by Apostolides; *ῥίνη* (v. l. *ῥίνα*), Arist. 543b 9, 540b 11, 746b 6, 543a 14, 565b 25, 1529a 16, 697a 6, 620b 30 31, 506b 8, 566a 20 22 27, 622a 13.

The *ῥίνη* is one of the *σελάχη*, has the gall on the liver, has a large tail and copulates belly to belly. It breeds twice a year, in autumn and again about the setting of the Pleiades, producing seven or eight young each time. It allows its young to pass in and out (of its mouth). The *ῥίνη* seems to cross with the *βάτος* and produce the fish called *ῥινόβατος*. This has the head and fore parts of the *βάτος* but the rear parts of the *ῥίνη*, as if born from both. Like the *ὄνος*, *βάτος* and *ψῆττα* it buries itself in the sand and then waves the filaments in its mouth. It changes its color to that of the rocks on which it is, or to that of its other surroundings, so that it is not easily seen.

Athen. vii, 89, says the *λειόβατος* (smooth *βάτος*) is also called *ῥίνη*.

Family **RHINOBATIDÆ.**

20. Rhinobatus columnæ (Muller & Henle).

Apost. 8. † *Καλκάνι*.

Family **TORPEDINIDÆ.**

21. Torpedo torpedo (L).

Apost. 8 (*Torpedo marmorata*), † *μουδιάστρα*, from M. G. *μουδιάζω*, to benumb. Compare ancient *νάρκη*, Aristotle, 506b 9, 505a 4, 540b 18, 566a 32, 695b 8 9, 696a 27, 1527b 40, 1530a 12, 696a 31, 695b 11, 620b 19 29, 1530a 15, 543b 9, 566a 23, 565b 25, 620b 20 26.

Νάρκη means *numbness, torpor, stiffness.* The verb *ναρκάω* means to *grow numb*, to *be stiff*, Lat. *torpere.*

Arist. gives the following points with regard to the *νάρκη*:

It is a flat *σέλαχος* and like all such has its gills underneath it and is ovoviviparous. It has the gall on the liver, has a long spiny

tail. It has its dorsal fins transferred to its belly, where, on account of its shape, they will be more useful, and its *belly* (ventral and pectoral [?]) fins near the head. It has two fins near (or on) its tail. For two fins it uses its flat edges. The *νάρκη* benumbing (*ναρκᾶν ποιοῦσα*) the fishes which it intends to catch, taking them into its mouth in the way which it has, feeds on these. It buries itself in the sand and mud and captures the fishes swimming up to it, which it stuns (*ναρκᾶν ποιεῖ*). A proof that they live in this way is that they are often caught having in them the *κεστρεύς*, one of the swiftest of fishes, the *νάρκη* itself being one of the slowest. Some persons have been eye witnesses of their mode of capturing their prey. It is well known that they stun people also. It hunts little fishes for its food, catching them by rendering them numb (*ναρκᾶν*) and unable to move. The *νάρκη* and *πίνη* spawn a little before the antumnal equinox. They take their young into themselves (their mouths) and let them out again. A large *νάρκη* has been seen with about 80 young in it.

Aristotle frequently mentions it in close connection with *τρυγών*, *βάτος* and *πίνη*, implying that they belong to the same general class.

See also Athen. vii, 95, where the same facts with regard to its stunning power are repeated. Theophrastus says it can send a shock even up through a fish-spear to a man's hand.

Family **RAJIDÆ**.

22. Raja clavata (L).

Apost. 8.

23. Raja batis (L).

Apost. 8 (*Raia batis*), *βατί*. *Βατί* = *βατί(ον)* is the natural M. G. equivalent for A. G. *βάτος*.

24. Raja punctata H., *βάτος* (1).

Apost. 8 (*Raia punctata*).

The *βάτος* is repeatedly mentioned in Aristotle. 489b 6, 489b 31, 505a 4, 540b 8, 565b 28, 566a 28 32, 599b 29, 620b 30, 695b 28, 696a 25, 697a 6, 709b 17, 746b 6.

According to Aristotle the *βάτοι* form one division of the *σελάχη*, are flat, have a tail (*κέρκος* = tail like that of a quadruped. The word *κέρκος* is not applied to the tail of a fish, such as a sunfish, etc.); they have uncovered gills (no opercula), have no scales, but a rough skin; they have no fins but "swim by means of their flatness itself," or, as is said in another place, by means of the outer

edge of their flatness. They have their gills *under* them, whereas the *γαλεώδη* have them in the side. The flat selache with tails, as the *βάτος*, *τρυγών* and the like, copulate not only with belly to belly, but also by mounting with their bellies upon the backs of the females in those kinds in which the tail is not so thick as to be in their way. Of the flat fish the *βάτος* and *τρυγών* do not receive their young into themselves because of the roughness of the tail. Some fishes lie quiet in the sand, others in the mud, keeping only the mouth above. The *πετραῖοι*, *βάτοι* and *σελαχώδη* lie hid during the wintriest days. The *ὄνος*, *βάτος*, *ψῆττα* and *ῥίνη* bury themselves in the sand, and when they have made themselves invisible they wave (*ῥαβδεύεται*) those things in their mouths which the fishermen call "rodlets" (*ῥαβδία*) or little wands. None of the other fishes have been seen uniting in copulation with others not of their own kind; but the *ῥίνη* and *βάτος* alone seem to do this; for there is a fish called *ῥινόβατος*, because it has the head and fore-parts of the *βάτος* but the hind parts of the *ῥίνη*, as if born from both of these. The *γαλεοί* and *γαλεοειδεῖς*, as the *ἀλώπηξ* and *κύων*, and the flat fishes, *νάρκη*, *βάτος*, *λειόβατος* and *τρυγών*, are viviparous, having produced eggs (internally), i. e. are *ovoviviparous*. *Βατίς* also occurs in Aristotle. It may be merely a feminine form of *βάτος* used as a name of female *βάτος*. 1527b 41 43, 565a 22 27, 567a 13. "The *σκυλία* and *βατίδες* have shelly arrangements in which is found an eggy fluid. The form of the shell is like that of the tongues (reeds) of wind-instruments (pipes, *αὐλοί*), and there are hair-like ducts attached to the shells. In the case of the *σκυλία*, which some call *νεβρίαι γαλεοί*, the young are produced whenever the shell breaks from around them and falls off; but in the case of the *βατίδες* whenever they lay the eggs the young comes forth from the shell, which has been broken off from around it." 565a 22ff. (The above passage is obscure and possibly corrupt. I do not understand the distinction made in the latter part.)

In 567a 13 Aristotle says that the female seal has a pudendum like that of the *βατίς*.

25. Raja miraletus H., *σελάχι* (1).

Apost. 9 (*Raia miraletus*). *Σελάχι*, according to Apost., is a collective name for all species of rays.

Arist. *σέλαχος*, commonly in plur. *σελάχη*. 511a 5, 695b 9, 489b 2, 516b 16, 655a 23, 732b 1, 754a 23, 476a 2, 732b 22, 520a 17, 538a 29, 540b 6, 755b 2, 598a 12, 591a 10, 697a 7, 516b 15, 516b 36,

655a 23, 696b 3 6, 697a 8, 517a 1, 476a 2, 489b 6, 505a 1 3 5, 695b 4, 489b 30, 676b 3 4 5, 520a 17 18 19, 564b 20, 718b 35, 733a 10, 754a 33, 733a 8 11, 537a 30, 535b 24, 538a 29, 540b 19 10 12, 621b 25 28, 570b 32, 489b 16, 718b 33, 754a 23 32, 564b 15 16, 492a 27, 503b 3, 511a 4 7 9 12, 516b 15, 475b 20, 676b 2, 718b 32, 732b 1, 754a 23, 755a 12, 755b 2, 676b 2, 566a 24, 570b 32, 566a 15, 565b 30, 566a 26, 571a 1, 540b 14, 755b 8 12, 539a 29, 505a 26, 489b 6, 540b 17, 505a 3, 517a 1, 540b 6 8 10 12 17, 565b 28, 489b 30, 565b 24–31, 695b 9, 1527b 40 44. Cf. also *σελαχώδεις*.

Σέλαχος is a term much used by Aristotle in a broad sense to include a wide variety of fishes. *Σελαχώδης* is also used, whether as equivalent to *σέλαχος* or in a still more comprehensive sense, is not clear. Pliny ix, 24 (78), says: "There is another kind of flat fishes which have cartilage for the spine (*pro spina*), as the *raiæ*, *pastinacæ*, *squatinæ*, *torpedo* and those which the Greeks call by the names *bovis* (*βοῦς*), *lamia*, *aquila* (*ἀετός*), and *rana* (*βάτραχος*), in which number are also the *squali* although these are not flat (*plani*). All these collectively Aristotle called *σελάχη*, he first having given them this name. We (Latins) can not give them a distinctive name unless we may be permitted to call them cartilaginous (*cartilaginea*)."

I gather the following points from Aristotle: Any animal is called a *σέλαχος* which, being without feet and having gills, is viviparous (or ovoviviparous). All the *σελάχη* except the *βάτραχος* are externally viviparous, having first produced eggs within themselves (i. e. are ovoviviparous).

Their uterus, or oviduct, is forked and extends to the *ὑπόζωμα* (diaphragm, peritoneum).

The *σελάχη* are *βάτος*, *τρυγών*, *ῥίνη*, *βοῦς*, *λάμια*, *ἀετός*, *νάρκη*, *βάτραχος* and all the *γαλεώδη*. They have uncovered gills; some are elongated in form, e. g. the *γαλεοί*; others flat, e. g. the *βάτοι*. Some of the *σελάχη* do not have fins, viz., the flat ones and those having tails, such as *βάτος* and *τρυγών*. These swim by means of the "flatness itself." But the *βάτραχος* has fins, and so do all which do not have the flat parts thin. Some are rough, others smooth. The viviparous fishes, such as the *σελάχη*, have cartilaginous bo[illegible] (are *χόνδρακανθα*), but the oviparous ones have a spine like the b[illegible] bone (*ῥάχις*) of quadrupeds. The liver of the *σελάχη* becon[illegible] and an oil is melted from it, although the *σελάχη* themselv[illegible] very free from fat both in their flesh and abdomen.

They sleep at times so that they are even caught with the hand; they take their young into their mouths, except the *βάτραχος*, are purely carnivorous, and most of them have no pyloric appendages; the female is larger than the male, and the males can usually be distinguished from the females by two appendages hanging near the vent.

All the *σελαχώδη* have at the same time ova in great numbers above near the *ὑπόζωμα*, some larger and others smaller, while they already have embryos below. They are rough and without scales. They lie torpid during the wintriest days.

Galen vi, 737, derives the name *σέλαχος* from *σέλας*, a bright light or blaze, or shining. He says: "The skin of such creatures is rough and shining in the night, wherefore also some say they have been named *σελάχια* from having *σέλας* (a phosphorescence).

26. Raja undulata (Lacépède).

Apost. 9.

27. Raja fullonica (L).

Apost. 9 (*Raja chagrinea*).

Family **AËTOBATIDÆ.**

28. Aetobatis aquila (L).

Apost. 9 (*Myliobatis aquila*). † *Ἀετός* = eagle, Lat. aquila. Arist. 540b 18 mentions *ἀετός* as one of the *σελάχη*. Compare Plin. N. H. 9, 78, aquila.

29. Aetobatis bovina (Geoffrey St. Hilaire).

Apost. 9 (*Myliobatis bovina*). *Χελιδόνα*, in some parts of Greece. *Χελιδόνα*, the swallow, is also a common M. G. name for *Trigla hirundo*, as I found in the market at Athens.

Family **DASYATIDÆ.**

30. Dasyatis pastinaca (L).

Apost. 9 (*Trygon vulgaris*). † *Τρυγών* at Paros, † *μούτρουβα* at Chalcis. Arist. 598a 12, 1527b 40, 695b 9 28, 489b 31, 540b 8, 565b 28, 566b 1, 540b 8, 620b 24. Athen. viii, 21. Lat. Trygon, Plin. 9, 155.

Τρυγών as a bird is the turtle-dove. The fish called *τρυγών*, says Arist., is a flat *σέλαχος* with no fins, but swimming by means of its flat parts, has a rough tail, does not admit its young into its mouth, is pelagic, buries itself in the sand.

Family **MANTIDÆ.**

31. Mobula edentula (Brünnich).

Apost. 9 (*Cephaloptera giorna*).

Family **CHIMÆRIDÆ.**

32. Chimæra monstrosa L.

Apost. 9.

Family **ACIPENSERIDÆ.**

33. Acipenser sturio.

Apost. 10 (*Acipenser sturio*), † στουρτόνι at Corfu.

Family **SILURIDÆ.**

34. Silurus glanis (L).

It is not known that this species really occurs in Greece.

35. Parasilurus aristotelis (Agassiz).

Apost. 31 (*Silurus glanis*). † *Γλανός*, called † *γουλιανός* (g(oo)l-(y)anós) at Larissa, where it is caught in the Penēus River. *Γλανός* at Vrachori. Aristotle 505a 17, 490a 4, 506b 8, 568b 15ff, 608a 3 4, 568a 22 b 22, 568a 25 b 14, 569a 3, 621a 21 b 2, 602b 22 24.

This species is identified by Apost. with the *γλάνις* of Aristotle. Agassiz and Garman refer Aristotle's account to *Parasilurus aristotelis*, found in the Acheloüs River, in Acarnania, Greece.

The *χορδύλος*, says Aristotle, swims with its feet and tail, and, to compare a small thing to a great, has a tail like the *γλάνις*. Some fish have four gills, each double except the last, as for instance *κίχλη*, *πέρκη*, *γλάνις*, *κυπρῖνος*. The *γλάνις* has the gall on the liver. The *γλάνεις* and *πέρκαι* emit the bunch of eggs (*τὸ κύημα*) united just as the *βάτραχοι* do. The larger *γλάνεις* lay their eggs in the deep places, some even a fathom deep, but the smaller ones lay them in more shallow water, usually near the roots of a willow or some other tree; also near the reed and the *βρύον* (some kind of a weed). The growth of the *γλάνις* from the egg is very slow, wherefore the male watches them forty or fifty days that the offspring may not be devoured by the little fishes which happen along. The egg of the *γλάνις* is, when laid, as large as a grain of vetch. No pestilential (universal?) disease attacks the fishes of rivers and ponds, but peculiar diseases fall on some of them, as the *γλάνις* especially,

because it swims near the surface, becomes star-struck in the time of the dog-star; it is also stupefied by loud thunder. The γλάνεις in the shallows are destroyed in large numbers by being struck by the dragon-serpent. The river and lake fish are best after the emission of the eggs and semen, when they recover their flesh. The γλάνις is not good while pregnant. In all the rest the males are better than the females, but the female γλάνις is better than the male.

Of the river fishes the male γλάνις bestows much care upon its young. The female departs when she has laid her eggs, but the male, remaining where most of the eggs collect, keeps guard over them, affording no other assistance except preventing the other small fishes from seizing the offspring. It does this forty or fifty days until the young, having grown, are able to escape from the other fishes.

Family CYPRINIDÆ.

36. Cyprinus carpio (L).

Apost. 30–31 (*Cyprinus carpio* and *collari*), called † πλατίτσα in Thessaly.

37. Carassius auratus (L.)

Apost. 31 (*Carassius auratus*), † κοκκινόψαρο, red-fish = † χρυσόψαρο, gold-fish. Κόκκινος is used of a light or yellowish-red, even of a yellow color, e. g. κοκκινάδι τοῦ αὐγοῦ is yolk of the egg.

38. Barbus meridionalis (Risso).

Apost. 31.

39. Tinca tinca (L).

Apost, 31 (*Tinca vulgaris*).

40. Leuciscus cephalus (L).

Apost. 31 (*Squalius cephalus*).

Family CLUPEIDÆ.

41. Harengula aurita (Cuv. & Val.) H. * Φρίσσα (1), λάμπρινα (1).

Apost. 31 (*Sardinella aurita*), † φίσσα, † θρίσσα, † σαρδελομάνα (mother of the sardine); † κέπτα at Corfu. Arist. 621b 16, 1528a 40. Athenaeus vii, 137.

Aristotle speaks of the θρίσσα as one of the more bony fishes. Athenaeus says Ναλκίδες and the like, θρίσσαι, τριχίδες, ἐρίτιμοι. Dorio mentions the river Θρίσσα and calls the τριχὶς τριχίας.

Plainly *θρίσσα* (*θρίχια*), *τριχίς* and *τριχίας* are all derived from *θρίξ* (gen. *τριχός*) hair. *Φρίσσα* and *φίσσα* are corruptions of *θρίσσα*.

42. Harengula phalerica (Risso).

Apost. 31 (*Meletta phalerica*), † *παπαλίνα*. A doubtful species.

43. Clupea pilchardus (L). H. *Σαρδέλα* (2), **τριχιός* (1).

Apost. 32 (*Alosa sardina*), *σαρδέλα*. *Σαρδέλα* is It. *sardelli*. This would seem to be connected by derivation with Lat. *sarda*, Plin. 32, 151 and 46; Sardina Col. 8, 17, 12. *Σάρδη* and *σαρδήνη*, Galen. *Σαρδῖνος*, Arist. 1531a 8, Athen. vii, 137.

Athenaeus says *Χαλκίδες* and the like, *θρίσσαι*, *τριχίδες*, *ἐρίτιμοι*. Epainetus, in his work on fishes, says *χαλκίδες*, which they also call *σαρδῖνοι*. Aristotle calls them (the *χαλκίδες* or *ἐρίτιμοι*) *σαρδῖνοι*.

It is evident from the above that the names *χαλκίδες*, *σαρδῖνοι*, *θρίσσαι* and *τριχίδες* were used for fishes similar to one another. This corresponds to the M. G. use of *θρίσσα* (*Harengula aurita*), *σαρδέλα* and *τριχιός*. *Θρίσσα* and *τριχίδες*, M. G. *τριχιός*, are derived from *θρίξ*, Gen. *τριχός*, hair, and doubtless refer to the fine hair-like bones of the sardines. Sardelli, sardinelli, *σαρδῖνοι*, may be diminutives from sarda, and all these words obviously are derived from *Σαρδώ*, the A. G. name of Sardinia. Cf. Athen. iii, 92 for *σάρδα* resemble the *κολίας* in size.

For *τριχιός* cf. *τριχίας* and *τριχίς* Arist. 569b 26, 598b 12, 543a 5, 1528b 1. The *τριχίας* breeds twice a year. From the Phaleric *κωβῖτις* are produced *μεμβράδες*, from these *τριχίδες*, and from these *τριχίαι*. The *τριχίαι* are caught only as they swim into the Pontus, but they are not seen coming out of it. Whenever one is caught in the neighborhood of Byzantium the fishermen cleanse their nets thoroughly, because it is not customary for it to swim out (i. e. they cleanse their nets because the catching of one is so unusual a thing as to be considered an evil omen and contaminating).

The reason for this is that they swim up the Ister (Danube) to where it splits and then come down into the Adriatic. This is proved by the fact that there the reverse happens; for they are not caught going into the Adriatic, but only swimming out.

Athen. vii, 137, *τριχίδες*. Aristophanes Knights, 662. *Τριχίδες* a hundred for an obol (3 cents).

44. Clupea alosa (L).

Apost. 32 (*Alosa finta*).

45. Clupea rufa (Lacépède).

Apost. 32 (*Alosa vulgaris*).

Family **STOLEPHORIDÆ.**

46. Stolephorus encrasicholus (L). H. **Γαῦρος* (1).

Apost. 32 (*Engraulis encrasicholus*), † *χαφί*. *Γαῦρος* means pròud, haughty, both in A. G. and M. G.

Family **SALMONIDÆ.**

47. Salmo fario (L).

Apost. 33 (*Trutta fario*), † *πέστροφα*.

Family **SYNODONTIDÆ.**

48. Synodus saurus (L). H. *Σκαρμός* (2).

Apost. 32 (*Saurus fasciatus*), *σκαρμός*. I find nothing corresponding to it in the A. G.

49. Aulopus filamentosus (Bloch).

Apost. 32.

Family **PARALEPIDIDÆ.**

50. Paralepis coregonoides (Risso).

Apost. 32.

51. Paralepis sphyrænoides (Risso).

Apost. 33.

Family **ANGUILLIDÆ.**

52. Anguilla anguilla (L). H. *Χέλι* (1).

Apost. 33 (*Anguilla vulgaris*), *χέλι*, † *σουβλομυτάρι* (spit-nose or awl-nose) at Missolonghi, † *γλαβίτσα* at Sciathus.

Χέλι is plainly the M. G. form of the A. G. *ἔγχελυς*. Arist. 489b 27, 534a 20, 505a 15, 506b 9, 507a 11, 517b 8, 538a 3 13, 696a 4 b 22, 1529a 37, 567a 20 21, 569a 6 8, 504b 30, 520a 24, 570a 3 15 24, 505a 27, 696b 22, 708a 4 7, 707b 28, 741b 1, 570a 13, 591b 30, 709b 12, 762b 23 28, 608a 5, 520a 24, 1529a 24–35, 569a 8, 538a 11, 592a 3–27. The *ἔγχελυς* is elongated and smooth, has only two fins, these fins towards the gills, has four single gills on each side, has the gall on the liver, has a gullet (*στόμαχος*), but this gullet is small, has but little fat about the stomach and caul, is neither male nor female, and does not engender anything from itself, as none of

them has ever been found with eggs in it. What they call a difference of male and female in the ἐγχέλυς, in that the so-called male has the head larger and longer and the female small and pug-nosed, is not a difference of sex but of species. All male fishes have milt (θύρος) except the ἐγχέλυς, but this has neither eggs nor milt. The ἐγχέλυς passes from the lakes into the sea. They are not produced either from copulation or eggs. In some marshy lakes when the water has all been drained off and the mud has been scraped out the eels (ἐγχέλειες) make their appearance again when the rain water collects. They are not produced in the dry places, neither in the permanent lakes, for they live and are nourished by the rain water. Some persons suppose they are produced from the little worms found in some ἐγχέλειες. This is not true, but they are produced from the so-called "entrails of the earth" (earth-worms), which originate spontaneously in the mud and moist earth. Some (eels) have already been seen coming out of these (earth-worms), and others may be seen in those pulled to pieces. But in the sea and in rivers such things are produced, especially where there is putrefaction, in the sea weed of the sea, and about the margins of rivers and ponds where the heat is intense.

The ἐγχέλυς requires pure water and soon suffocates in foul water. The eel-raisers (ἐγχελοτρόφοι) keep the water constantly flowing in and out of their tanks. Those who fish for eels (ἐγχέλειες) stir up the water. The ἐγχέλειες which have died do not come up and float on the surface like most fish, for they have the stomach (κοιλία) small. (Possibly κοιλία, literally hollow, here means swimming bladder.) A few of them have fat, but most of them have not. They live five or six days out of the water, more when they are northern, fewer when southern. If transferred in spring from the lakes to the tanks they die, but not so in the winter. They do not endure violent changes of temperature, dying if plunged into cold water. Some live seven or eight years. The river ἐγχέλειες take food, devouring one another and plants and roots, and whatever they find in the mud. They feed mostly at night, but during the day they retire into the depths. Those which men call the females are the better; but they call them so by mistake, they being of different species.

The word ἐγχέλυς is at least as old as Homer (Il. 21, 203 and 353), and is probably cognate with the Latin *anguilla* and English *eel*.

Family **CONGRIDÆ.**

53. Ophisoma balearicum (De La Roche). H. * *Ζαλούπαρδος* (1).

Not seen by Apostolides. If the word is genuine Greek it must mean foam-leopard or storm-leopard, from *ζάλη* (*ζάλος*), surging, foam, storm, and *πάρδος*.

54. Leptocephalus conger (L). H. *Μουγγρί* (1).

Apost. 34 (*Conger vulgaris*, variety *Conger niger*), *μουγγρί*, † *δρόγγα* at Missolonghi. The *γόγγρος* of Aristotle 489b 27, 590b 17–19, 505a 27, 505a 14, 696a 4, 708a 3, 507a 10, 506b 18, 571b 1, 571a 28, 599b 6, 707b 28, 591a 6 10 18, 610b 15–17, 598a 13.

All those fishes which are long and smooth, as the *ἐγχέλυς* and *γόγγρος*, have only two fins. Some fishes have two gills on each side, the one single and the other double, as e. g. the *γόγγρος* and *σκάρος*. Some of the *γόγγροι* have the gall upon the liver, others below, separated from it. A few of the fishes have a gullet (*στόμαχος*), as e. g. the *γόγγρος* and *ἐγχέλυς*, and these have it small. (For *στόμαχος* = *οἰσόφαγος* cf. 495a 18 b 19, 496a 2.) Only those fishes which lay the crumbling spawn (*τὸ ψαθυρὸν ᾠόν*) have thin scales (*λεπίδες*). For the *γόγγρος* does not have such spawn, neither does the *μύραινα* nor the *ἐγχέλυς*. The *γόγγροι* also have egg-masses (*κυήματα*), but the egg-mass is not very apparent on account of the fat. It has a long egg-mass just as serpents have. But when placed upon the fire it makes its nature evident, for the fat smokes and melts but the eggs jump and crackle when squeezed out. And besides, if a person feels and rubs them with his fingers the fat feels smooth, but the spawn rough. Now some *γόγγροι* have fat but no spawn, while others, on the contrary, have no fat and much spawn, as has just been described. The *κάραβοι* (Spiny lobsters?) overpower the *γόγγροι*; for on account of the roughness of the *κάραβοι* the *γόγγροι* do not slip away from them. The *γόγγροι*, however, devour the *πολύποδες*, for the *πολύποδες* cannot manage them on account of their smoothness. Some *πολυπόδες* have their arms (*πλεκτάνας*, coils) eaten off by the *γόγγροι*. The *μύραινα*, *ὀρφός* and *γόγγρος* also hibernate (*φωλοῦσιν*, lie quiet or torpid). Frequently the *κεστρεῖς* and the *γόγγροι* live when the tail has been taken away up to the vent. The *κεστρεύς* is eaten off by the labrax and the *γόγγρος* by the *μύραινα*. The battle is to the stronger against the weaker, for the stronger devour the weaker. Some of the fishes change their places from the open sea to near the land and from the

land to the open sea, avoiding the extremes of cold and heat. The τρυγών, σελάχη, white γόγγροι, χάννη, ἐρυθρῖνος and γλαῦκος are pelagic (πελάγιοι); but the φάγροι, σκόρπιοι, black γόγγροι, μύραιναι and κόκκυγες change from one place to the other. Some of the long and thick fishes, as the ἐγχέλυς, γόγγρος, etc., do not have the fins on the belly (i. e. the ventral and anal fins). They all eat one another (except the κεστρεύς), and the γόγγροι especially do so. Some have only two fins, as the γόγγρος, ἐγχέλυς, and a certain kind of κεστρεύς.

Latin *Conger* cf. Plin. N. A. 9, 72, 9, 57, 9, 87, 9, 185. Also *gonger*, 32, 147.

Family **ECHELIDÆ.**

55. Echelus myrus (L).

Apost. 34 (*Myrus vulgaris*).

Family **OPHISURIDÆ.**

56. Ophisurus serpens (L).

Apost. 34 (*Ophisurus serpens*), † φίδι τῆς θαλάσσης, serpent of the sea. Arist. θαλάττιοι ὄφεις, 505b 8 10, 621a 2.

The sea serpents (θαλάττιοι ὄφεις) are in other respects similar in form to the land serpents, but they have the head more conger-shaped; there are many kinds of the sea serpents, and they have every sort of color. They are not found in very deep places.

In the second reference Aristotle seems partly to contradict the above, saying, the sea serpent's color and body are similar to those of the γόγγρος except that it is of a duller color and more violent in its movements. If it is caught and let go it quickly goes down into the sand, boring through it with its beak. It has a sharper mouth than the serpents.

Family **MURÆNIDÆ.**

57. Muræna helena (L). H. Σμέρνα (1).

Apost. 34 (*Muræna helena*), σμέρνα and † σμύρενα. A. G. both σμύραινα and μύραινα. Arist. 707b 29 31, 489b 28, 540b 1, 517b 8, 540b 34, 696a 6, 1530a 9, 591a 12, 598a 14, 543a 25 29, 504b 34, 505a 15, 696a 6, 506b 16, 599b 6, 540b 1, 543a 20 23 24 28, 153 10, 1530a 8, 610b 17. Athen. vii, 90.

Σμύραινα is identical with the form σμύρενα given by Ap as both spellings would be pronounced exactly the same in

G. Σμέρνα, the usual M. G. form and the only one which I heard, is plainly a corruption of the same word.

According to Aristotle the μύραινα is a *long* fish, does not have a crumbling egg-mass, has no scales, eats flesh only, is alternately pelagic and littoral, lies torpid for a season, is stronger than the γόγγρος and eats off the tail of the γόγγρος, has no fins, and uses the sea as serpents do the land; (*i. e.* moves through the sea in the same way as serpents move over the ground); its gills are not articulated like those of other fish; it has four single gills on each side, has the gall bladder on the entrails and is long like a snake; they copulate by twining around one another and bringing belly to belly like snakes, spawn at any and every season, lay many eggs, and the young grow rapidly. "The σμῦρος and the σμῦραινα differ, for the σμῦραινα is variegated and weaker, but the σμῦρος is of uniform color and strong, and it is colored like the pine tree and has teeth both within and without. People say, just as they say other things, that the one is male the other female. These come out on the dry land and are caught there frequently.

According to Athenaeus, Theophrastus says the ἐγχέλυς and μύραινα can live a long time out of water, because they have small gills. Dorio says the river μύραινα has, like the ὀνίσκος, only one spine. Some people claimed that the μύραινα came out on land and held intercourse with snakes, from which were engendered venomous μύραιναι.

Athen. vii, 91, μῦρος. There are two kinds, one black and the other reddish, but the black ones are best. Lat. *Muræna.*

In ancient writings the μύραινα, γόγγρος and ἐγχέλυς are regularly mentioned together showing that there was some considerable resemblance to one another, and that they were regarded as all belonging to the same general class. In connection with the current report noted by Aristotle to the effect that of μῦρος and μύραινα one was male the other female, it is interesting to note that the same belief is current among the fishermen of Greece of the present day. I was told in the market at Athens that *Muræna helena* was the female and *Gymnothorax unicolor* was the male of the same species, both called σμέρνα.

58. Gymnothorax unicolor (De La Roche). H. Σμέρνα (1).

Not noticed by Apostolides. Said by the Greek fishermen to be the male, while *Muræna helena* is considered the female σμέρνα. For ancient references to the σμύραινα or μύραινα see ***Muræna helena.***

Family **ESOCIDÆ.**

59. Esox belone (L). H. *Ζαργάνα* (1).

Apost. 32 (*Belone acus.*), † *βελονίδα, ζαργάνα.* Aristotle makes frequent mention of a fish called *βελόνη. Βελονιδα* would be a natural M. G. equivalent for this. See Arist. 610b 6, 506b 9, 543b 11, 571a 2ff, 567b 18, 755a 33, 616a 32.

Βελόνη = needle. Cont. Lex. gives also *βελονίδι* and *βελόνι* as names for the needle-fish.

From Aristotle I glean the following statements with regard to the *βελόνη*:

It is a long fish (i. e. not flat) and has the gall bladder on the liver. It spawns in winter. When it is time for it to spawn it bursts open and so the eggs come out; for this fish has a sort of division (partition) under the belly and intestine (*ἦτρον*) just as the snakes called *τυφλίναι* have. After it spawns these parts grow together again. Its eggs are spread around it just as in the case of the spiders, for the female *βελόνη* lays them attached to herself, and if any one touches them they scatter. The *βελόναι* run in shoals. The halcyon seems to make its nest chiefly from the bones of the *βελόνη*.

See Athen. vii, 111,, where *βελόνη* = *ῥαφίς*. Vide under *κατρυλίδρα, σακκυράφα, Syngnathus acus.*

Ζαργάνα. Cont. Lex. *ζαργάνη* and *σαργάνα*, needle-fish. *Σαργάνη* in A. G. means a braid, a basket. Arist. 610b 6, has *σαργῖνος* mentioned among fish found in schools. This may easily be a mistake for *σαρδῖνος. Σαργῖνος* occurs also in Athen. vii, 313 and 321. The name seems to be a derivative of *σαργός*. Cf. also Athen. viii, 52, *ῥαφίς* or *βελόνη*, called also *ἀβλεννής*.

Family **EXOCŒTIDÆ.**

60. Scombresox rondeletii (Cuv. & Val).

Apost. 32.

61. Exocœtus volitans (L).

Apost. 32 (*Exocœtus volitans*), *χελιδονόψαρο(ν)*, swallow-fish. The specimen sold me under the name *χελιδονόψαρο(ν)* was *Dactylopterus volitans*, Apost. 15, also given as *χελιδονόψαρο* by Apostolides.

Family **SYNGNATHIDÆ.**

62. Hippocampus hippocampus (L).[1] H. *Ἀλογάκι* (1).

Apost. 11 (*Hippocampus brevirostris*), *ἀλογάκι*, little horse. This would seem to be the fish called *ἱππόκαμπος* by the ancients. Aris-

[1]Apostolides records also *Hippocampus guttulatus* Cuvier—probably an error in identification, as the American species is unknown in the Mediterranean.

totle does not mention the ἱππόκαμπος. The word was used by the poets as the name of a sea monster, half horse and half fish, on which the sea gods rode. As the name of a fish it seems to occur only in late writings. Its stomach was regarded as a poison of peculiar power and also as possessing medicinal and magic powers. See Menand. Incert. 211, Strabo 384, Philostratus 774, Dioscorides 2 3, Aelian N. A. **14,** 20, Plin. N. H. **32,** 58 67 83 93 109 113 139 **149, 36,** 26. The references in Pliny refer chiefly to the use of the Hippocampus and its ashes as a medicine. In none of the references which I have examined in either Greek or Latin is there anything given, so far as I can see, which helps to identify the animal. The only reason, so far as I know, for identifying it with the sea horse is the mythological use of the term and the fact that the first part of the name is undoubtedly ἵππος, horse. Τὸ κάμπος occurs as the name of a sea monster in Lycophron 414. Κάμπη = caterpillar. Κάμπτω ✓καμπ = to bend. These words may all be connected in origin and meaning.

Ἱπποκάμπιον, Epicharmus 16, Ahr.

63. Siphonostoma acus (L). H. Κατρολίδρα (₂).

Apost. 11 (*Syngnathus acus*), κατουρλίδα, †σακκοράφα (sack-needle).

Ῥαφίς (Gen. ῥαφίδος), needle, occurs as the name of a fish in Athen. vii, 111. In a quotation from Epicharmus occurs the expression ὀξύρυγχοι ῥαφίδες, sharp-billed ῥαφίδες. Dorio says "the βελόνη which they call ῥαφίς," needle. Arist. in the fifth book of Parts of Animals calls it βελόνη, but in his work on animals or fishes, having called it ῥαφίς, he says that it is toothless. Speusippus calls it βελόνη. Cf. βελονίδα.

64. Typhle typhle (L). H. Κατρολίδρα (₂).

Apost. 11 (*Siphonostoma argentatum*).

65. Syngnathus æquoreus (L).

Apost. 11 (*Entelurus anguineus*) may be some other species instead of *S. æquoreus.*

Family **MUGILIDÆ.**

66. Mugil cephalus (L). H. Κέφαλος (₂).

Apost. 27 (*Mugil cephalus*), κέφαλος, †γοβύλι at Chalcis; at Missolonghi the males are called †στειράδια, the females †μπάφες.

Κέφαλος is common in Arist. See 543b 15, 567a 19, 570b 15, 591a 13–30, 602a 4, 1529b 17. The κέφαλος, according to Aristotle, is one kind of κεστρεύς. It begins to be pregnant in November or December and is pregnant thirty days; it has scales and is oviparous, feeds on mud or slime; like all the κεστρεῖς it is not carnivorous; these (the κεστρεῖς) are the only fishes which are not carnivorous, and have never been caught with any flesh in their stomachs. The fishermen never use flesh bait for them, but use barley-cake. The κεστρεῖς all feed on sea-weed and sand. The κέφαλος, which some call χελών, is a littoral fish. The κέφαλοι feed on mud, and for this reason they are heavy and slimy. The winter is beneficial to most fishes, but not so to the κεστρεύς and κέφαλος. The κέφαλος especially suffers from the rain and cold in winter. Their eyes become white and the fishes become blind and light in weight, and finally die. In the shallows at Nauplia and elsewhere many have been caught blind when there came severely cold weather. The eyes of many were white. Athen. vii, 77–79 under the heading κεστρεύς has many references to the κέφαλος, which is regarded as one kind of κεστρεύς. He says that Dorio in his work on fishes describes the marine division of the κεστρεῖς but does not consider the river κεστρεύς. He makes the kinds of marine κεστρεύς to be κέφαλος and νῆστις.

Hesychius, under the word κέφαλοι, says some of the κεστρεῖς are so called.

There is some confusion in regard to the relation of the κέφαλοι and κεστρεῖς, but in general the κέφαλοι are spoken of as a subdivision of the κεστρεύς. In some places, however, they seem to be distinguished from one another. Κεστρεύς seems to have been used in a double sense, at times in a broad sense including the κέφαλοι, and again in a more restricted sense.

67. Mugil capito (L). H. Κέφαλος (1).

Apost. 27 (*Mugil capito*), †λαγιάδες at Chalcis, †βελάνισες at Aitolico. For ancient use of κέφαλος v. sub. *Mugil cephalus*. A fish seems to have been called λαγώς, the hare, in ancient times, but I can find nothing definite about it. *Lepus marinus*, the sea hare, is very common in Pliny, where it is represented as exceedingly venomous. Vide Plin. 9, 155, 32, 9. The name most like βελάνισες are βελόνη and βλέννος. Of the latter Athen. vii, 29, says it resembles the κωβιός in appearance.

68. Mugil saliens (Risso).

Apost. 27 (*Mugil saliens*), † *μυξινάρι*, at Missolonghi and Chalcis. † *Κεφαλάδες* at Volo. For *κεφαλάδες* compare *κέφαλος*. † *Μυξινάρι* would be natural M. G. form of *μύξων*, found in A. G. writings. Arist. 570b 2, 543b 15. Written also *σμύξων*. The name is from *μύξα*, mucus, slime; usually the mucous discharge from the nose. According to Arist. the *χελών*, *σάργος*, *(σ)μύξων* and *κέφαλος* are different kinds of *κεστρεύς*. Athen. vii, 77, under *κεστρεύς*, has as one kind *μυξῖνος*. This is an inferior kind of *κεστρεύς*, the *κέφαλος* being best.

69. Mugil labeo (Cuvier).

Apost. 27 (*Mugil labeo*), † *γάστρος*. † *Πλαταρίδα* at Chalcis. *Γάστρος* is obviously from *γαστήρ*, belly, and may mean big-bellied fish.

70. Mugil chelo (Cuvier).

Apost. 27 (*Mugil chelo*), † *χελώνια*. Arist. 543b 15, 570b 2, 1529b 17 19, 591a 23.

Of the *κεστρεῖς*, says Aristotle, the *χελῶνες*, the *σάργος*, the one called *σμύξων* and the *κέφαλος* begin to be pregnant in December. The *κέφαλος*, which some call *χελών*, is littoral, but the *περαίας* is not.

See also Athen. vii, 77.

71. Mugil curtus (Yarrell).

Apost. 27 (*Mugil curtus*), called at Missolonghi † *μαυράκι*, black, when small, and † *λευκύνος*, white, when full grown. This is a doubtful species, unknown to us.

It seems evident that *Mugil* is the *κεστρεύς* of Aristotle and other A. G. writers, and that the *κέφαλος*, *μύξων* and *χελών* are species under this.

Family **ATHERINIDÆ.**

72. Atherina hepsetus (L).

Apost. 27 (*Atherina hepsetus*), *ἀθερίνα*. Arist. mentions the *ἀθερίνη* 570b 15 and 571a 6; also *ἀθερῖνος*, 610b 6. He says it lays its eggs near the land, rubbing its belly on the sand. The *ἀθερῖνοι* are gregarious, i. e. they go in shoals.

73. Atherina boyeri (Risso). H. *Ἀθερίνα* (1).

Apost. 28 (*Atherina boyeri*).

74. Atherina mochon (Cuvier & Val). H. Ἀθερίνα (1).

Not noticed by Apostolides.

Family SPHYRÆNIDÆ.

75. Sphyræna sphyræna (L). H. Λουτζος (1).

Apost. 28 (*Sphyræna spet*), λουτζος and † σφύραινα, the σφύραινα of Aristotle, 610b 5. The σφύραινα is gregarious.

Athen. vii, 122. The Attic Greeks call the σφύραινα κέστρα. Speusippus says that the κέστρα (or σφύραινα) βελόνη and σαυρίς are similar.

Family XIPHIIDÆ.

76. Xiphias gladius (L.)

Apost. 21 (*Xiphias gladius*), † ξιφιός. Hesychius gives ξιφιός as equal to ξιφίας. The name is derived from ξίφος, sword, and means sword-fish. For ξιφίας see Aristotle 1530a 17–21, 505b 18, 506b 16, 602a 26 30.

Arist. says of the ξιφίας: It has eight double gills on each side, and has the gall on the entrails; in the dog-days it has beside its fins a sort of little worm called οἶστρος, like a scorpion, as large as a spider. These cause them such pain that at times the ξιφίας leaps out of the water like the dolphin, and at times they even fall into boats.

Athen. vii, 96, says that Aristotle says: "The ξιφίας has the under part of its beak short but the upper part bony and large, equal to its whole size. This is called the sword (ξίφος), but the fish has no teeth."

Family ECHINEIDIDÆ.

77. Echeneis naucrates (L).

Apost. 22.

78. Remora remora (L).

Apost. 22 (*Echeneis remora*).

Family CORYPHÆNIDÆ.

79. Coryphæna hippurus (L.)

Apost. 21 (*Coryphæna hippurus*), † λαμπούγα, † μανάλια.

Family **TRICHIURIDÆ.**

80. Trichiurus lepturus (L).

Apost. 22 (*Trichiurus lepturus*), † *σπαθόψαρο*, blade-fish.

81. Lepidopus caudatus (Euphrasen).

Apost. 22 (*Lepidopus argenteus*), † *ἴλιος* at Patras and † *ἴλιαχας* at Corfu.

Family **SCOMBRIDÆ.**

82. Scomber scombrus (L).

Apost. 19 (*Scomber scomber*), *σκουμβρί*.

83. Scomber colias (Gmelin). H. *Σκουμβρί* (1), *σκομβρί* (1), * *τσῆρος* (1).

Apost. 19 (*Scomber colias*), *κολιός*.

The specimen which I bought as *κολιός* got lost, so that although I secured the name I can not be sure of the species to which it was attached.

Arist. *σκόμβρος*, 610b 7, 597a 22, 571a 14, 571a 12, 599a 2. The *σκόμβροι* copulate about April and spawn about July or August. The weaker animals always migrate first at each extreme of heat or cold, the *σκόμβροι* before the *θύννοι*, and the quails before the cranes. Frequently when the south wind blows against the *κολίαι* and *σκόμβροι* as they are swimming out of the Black Sea, they are caught below more than about Byzantium. *Κολίαι*, *σκόμβροι* and *πηλαμύδες* run in schools. Athen. vii, 116. Hicesius says the *σκόμβροι* are less in size than the *κολίαι*, but more nutritious. Arist. *κολίας*, 610b 7, 543a 2, 598a 24. The most of the *κολίαι* do not migrate into the Pontus but pass the summer in the Propontis and spawn, while they pass the winter in the Aegæan. The *κολίαι* are caught when they are passing into the Propontis, and in smaller numbers as they pass out. They are best in the Propontis before they spawn. The *σκόμβροι* and *κολίαι* (are gregarious) go in schools.

Athen. iii, 92. The *σάρδα* is like the *κολίας* in size.

84. Gymnosarda alliterata (Rafinesque).

Apost. 19 (*Thynnus thynnina*), † *τονίνα* at Chalcis.

The tunny (*θύννος*, fem. *θύννα* and *θυννίς*), is probably mentioned oftener than any other fish in A. G. writers. Arist., *θύννος*, 488a 6, 505a 27, 591a 11, 537a 21 23, 543a 12, 571a 12 8, 607b 32, 607b 28, 599b 9 sq., 602a 31, 543a 1 b 3, 571a 15 14, 598b 19, 597a 22, 557a 27, 598a 18, 602a 26, 1531a 30, 844a 29. *Θυννίς*, 591b 17, 610b 4, 1528b 6, 543a 9, 543b 12, 598a 26, 571a 10 15 18.

I glean the following points concerning the tunnies from Aristotle: The θύννοι are migratory and run in schools, are smooth, purely carnivorous, and have the net thrown around them sometimes while asleep; the female has a fin called ἀφαρεύς under the belly, but the male does not have it; they are at times burst by their fat. They live two years. The fishermen think this is proved by the fact that when the θυννίδες failed one year the θύννοι also failed the next year. They seem to be a year older than the πηλαμύδες. The θύννοι and σκόμβροι copulate about the first of April and spawn about the last of June or first of July. They lay their eggs in a sort of sack. The growth of the θυννίδες is rapid, When they spawn in the Pontus (Black Sea) there come from the eggs what some call σκυρδύλαι, but the Byzantians αὐξίδες (growers), because they grow (αὐξάνω) in a few days. They go forth (out of the Pontus) in autumn with the θυννίδες, but return in the spring, being already πηλαμύδες.

An old θύννος has been caught whose weight was fifteen talents (1350 lbs.), and whose length was five cubits and a span (about 8 ft.). The old ones are not good even for salt fish. The θύννοι lie torpid in the depths of the sea in winter, and are plumpest after this hibernation. They begin to be caught about the beginning of summer (the rising of the Pleiades), and are caught last at the setting of Arcturus (winter solstice?). The θύννοι, most of all fishes, take pleasure in warmth and come to the sand near the land for the sake of the warmth, because they warm themselves and swim on the surface. They spawn in the Pontus (Black Sea) and nowhere else, and but once a year. The θύννος is good to eat again after Arcturus (probably the rising of Arct., about Sept. 15), for during this season it ceases to be afflicted with the οἶστρος, because of which pest it is inferior during the summer. The θύννοι and ξιφίαι are infested by the οἶστρος about the dog-days. At that time they both have by their fins a sort of little worm called οἶστρος, like a scorpion and as large as a spider (ἀράχνης). These cause them such pain that the ξιφίας leaps out of the water at times no less than the dolphin. The θυννίδες and πηλαμύδες enter the Pontus in spring and pass the summer there both for food and spawning. They come out straightway after the Pleiad (probably the setting of the Pleiades, about Nov. 10). If the wind is a southern one they swim out more slowly, but if northern more quickly, because the wind is then for wafting them on. They swim into the Pontus, keeping close to

favorable the land on their *right*, but they swim out of it keeping close to the land on the *left*.[2] The *σκόμβροι* are weaker than the *θύννοι* and migrate earlier. The *θυννίς* spawns in summer about the month Hecatombæon near the vernal equinox. It lays a sort of sack filled with many small eggs.

The above are, so far as I can make out, the main points which Aristotle reports concerning the *θύννοι* and *θυννίδες*. Whether they are the same, the latter merely referring to the females, is not altogether clear. It will be noted that some of the above statements are obscure and others contradictory, at least apparently so.

85. Albacora thynnus (L).

Apost. 19 (*Thynnus thynnus*), *μαϊάτικο*. †*Γύφος* at Leucas, †*γλουπέας* at Zante. *Μαϊάτικο* means May (-fish). I saw this fish in the market at Athens and heard this name, but the fish was too large to take a specimen of it, the specimens which I saw being, if my memory serves me right, some five or six feet long.

86. Gymnosarda pelamys (L).

Apost. 19 (*Thynnus brachypterus*), †*ὀρκύνος* and †*κόπανος* in the Gulf of Volo. *Κόπανος* = a knocker, pounder, pestle. Aristotle has *ὀρκύνες* (*ὀρκύς*), 543b 5. He says they spawn in the open sea.

Athen. vii, 98, has *ὄρκυνος* as name of a fish. "Dorio, in his work on fishes, says that the *ὄρκυνοι* crossing over from the sea about the Pillars of Hercules come into our waters, wherefore most are caught in the Spanish and Tyrrhenian Seas (the sea west of Italy was called Tyrrhenian). From there they scatter throughout the rest of the (Mediterranean) sea. Hicesius says that those caught at Gadeira (Gades, Spain) are fattest, and next to these, those caught in Sicily; but those which are far from the Pillars of Hercules are poor, because they have swum for a greater distance." Aelian, Nat. An. i, 40, speaks of the *ὄρκυνος* as a monstrous (*κητώδης*) fish very skilful in getting the hook out of its mouth when caught. According to Sostratus, Athen. vii, 66, the *ὄρκυνος* is simply a *θύννος* grown very large. So also Archestratus, Athen. vii, 63.

87. Sarda sarda (L). II. *Παλαμύδα* (1).

Apost. 19 (*Pelamys sarda*), *παλαμύδα*. Aristotle has the name *πηλαμύς*,—*ύδος*. 488a 6, 610b 6, 543a 1, 543b 2, 598a 26, 571a 19,

[2]Probably meaning on what is their left as they go in; for he proceeds to say that some persons assigned as the reason for this that they have keener vision in the right eye than the left, implying that they always keep the right eye towards the land.

571a 11. The *πηλαμύδες* are migratory and run in schools. The *πηλαμύδες*, *θυννίδες* and *ἀμίαι* run into the Pontus (Black Sea) in the spring and pass the summer there, spawning about the mouths of streams. The young of the *θυννίδες* are of rapid growth. In the autumn they go out of the Pontus with the *θυννίδες* and are then called *σκορδύλαι* (or *αὐξίδες*). The next spring they return, being already grown to be *πηλαμύδες*.

The general belief of the fishermen from whom Aristotle derived his information seems to have been that the *πηλαμύδες* were simply half-grown tunnies. The first year they were *σκορδύλαι*, the second year *πηλαμύδες* and the third year *θυννίδες* or *θύννοι*. Athen. vii, 66, reports that Sostratus says the *πηλαμύς* is called *θυννίς*, and when it gets larger *θύννος*, and still larger *ὄρκυνος*. Cf. Strabo 549, *κορδύλη*, *θύννη*, *πηλαμύς*. Pliny, 9, 47.

Family **CARANGIDÆ.**

88. Trachurus trachurus (L). H. * *Κοχάλι* (1).

Apost. 19 (*Trachurus trachurus*), *σαυρίδι*. *Κοχάλι* in M. G. means *bone* or *little bone*. Arist. (528a 9, 761a 21) uses *κοχάλιον* as name of the snail. For *σαυρίδι* see under *Trachurus mediterraneus*.

89. Trachurus mediterraneus (Stemdachus). H. *Σαυρίδι* (2), * *σαμπανιός* (1).

Not distinguished by Apostolides. *Σαῦρος* = lizard, is used as name of a fish by Aristotle 610b 5. It is gregarious. In Athen. vii, 120, the name is given as that of a fish, and it is substantiated by several quotations, but nothing is given which would help to identify the fish. Athen. vii, 122, says Speusippus represents the *κέστρα*, *Βελόνη* and *σαυρίς* (acc. *σαυρίδα*) as similar. *Σαυρίδι* is a regular M. G. form of *σαῦρος*.

90. Decapterus suareus (Risso). H. * *Κοχάλι* (1).

Apost. 20 (*Caranx suareus*), *σαυρίδι κυνηγός*, hunter *σαυρίδι*.

91. Naucrates ductor (L).

Apost. 20 (*Naucrates ductor*), † *κουλαγοῦζος*.

92. Lichia glauca (L). H. *Λίτσα* (1).

Apost. 20 (*Lichia glaucus*), *λίτσα*.

93. Lichia amia (L).

Apost. 20 (*Lichia amia*), † *γκιφάρι*, † *γουφάρι*, † *γομφαρί*, † *λουφάρι*. *Γόμφος* (a bolt, pin or spike) and its diminutive *γομφάριον* were

ancient names for a fish. They are found in Tzetzes and Oppian or their scholia. See L. & S. under the words. Compare *γυφάρι, *Pomatomus saltatrix.*

94. Lichia vadigo (Risso).

Apost. 20.

Family **POMATOMIDÆ.**

95. Pomatomus saltatrix (L). H. *Γυφάρι (1).

The common Blue-fish of America; not noticed by Apostolides. This name is probably the same as γουφάρι reported by Apost. 20 as common name for *Lichia amia*, where see. The man who sold me the specimen probably did not distinguish it from *Lichia amia.*

The names are no doubt shortened from γομφάριον, a diminutive of γόμφος. This is proved by the existence of γομφάρι as a parallel form (see *Lichia amia*). Both γόμφος and γομφάριον occur in Tzetzes and Oppian (or their scholia) as the name of a fish.

L. & S. give γομφάριον = κεστρεύς and refer to Tzetzes ad Lycophronem 664, and Schol. Oppian H. 1, 112, 3, 339, and a gloss, γόμφος ἰχθύς. Γόμφος means a bolt, pin or spike.

Both γόμφος and its diminutive γομφάριον were clearly used as names of a fish or fishes; but the authority of Tzetzes, a Byzantine Greek of the Twelfth Century, A. D., or of a late scholiast on Oppian is not sufficient to prove that it meant κεστρεύς.

Family **ZENIDÆ.**

96. Zeus faber (L). H. Σαμπχέρο (1).

Apost. 21 (*Zeus faber*), σανπιέρος, σαινπιέρης, †χριστόψαρο (Christ-fish). The first three forms of the common Greek name seem to be corruptions of the French or Italian for Saint Peter.

97. Zeus pungio (Cuv. & Val).

Apost. 21.

98. Capros aper (L).

Apost. 21.

Family **STROMATEIDÆ.**

99. Stromateus fiatola (L).

Apost. 21.

Family **CEPOLIDÆ.**

100. Cepola tænia (L). H. **χροσταλῆδα* (1).

Apost. 22 (*Cepola rubescens*), † *τσίπουλα*.

The name *Cepola tænia* has priority over *C. rubescens*. J.

Family **TRACHYPTERIDÆ.**

101. Trachypterus spinolæ (Cuv. & Val).

Apost. 23.

102. Trachypterus trachypterus (L).

Apost. 23 (*Trachypterus falx*).

Family **SERRANIDÆ.**

103. Dicentrarchus labrax (L). H. *Λαβράκι* (1).

Apost. 17 (*Labrax lupus*), *λαβράκι* (for all species of this genus).

Aristotle *λάβραξ* 489b 26, 534a 9, 537a 27, 543a 1 b 11, 567a 19, 570b 20, 591a 11 b 18, 601b 29–31, 607b 26, 610b 10, 1530a 1–4.

The *λάβραξ* has scales and is oviparous, as all fishes with scales are, is carnivorous, has two fins on its back and two on its belly, has an especially acute sense of hearing, is often speared in daytime while sleeping, spawns twice a year, once in summer and once in winter, spawns chiefly "where rivers flow," has a stone in its head, and in consequence of this is especially apt to suffer in winter, being frozen to death and cast ashore. They are not good for food when pregnant. The labrax and cestreus, although most hostile to one another, flock together at certain seasons. For frequently not only those of the same species flock together but also those whose food is the same or similar, if it is plenty. Athenaeus, vii, 86. The *labrax* has a tongue that is bony and grown fast, and a triangular heart. It is the most intelligent of fishes, being quick to see a means of escape. Its name is derived from *λάβρος*, violent, greedy.

104. Dicentrarchus punctatus Bloch.

Apost. 17 (*Labrax punctatus* and *L. lupaster*).

105. Serranus scriba (L). H. *Πέρκα* (3).

Apost. 17 (*Serranus scriba*), *πέρκαι*.

Aristotle *πέρκη*, 505a 16, 508b 17, 568a 20 22, 599b 8, 1528a 12. According to Aristotle the *πέρκη* has four gills on a side, double except the last, just as is true also in case of the *κίχλη*, *γλάνις* and

κυπρῖνος. It has many pyloric appendages, spawns in the stagnant parts of rivers and lakes, among the reeds; the eggs cling together in a large bunch and the fishermen gather them by unwinding them from the reeds.

The χίχλαι, κόττυφοι and πέρκαι are given as πετραῖοι, or rock-fishes, and are said to hibernate and nest in pairs.

Athen. iv, 13. "Flowery-colored πέρκη." Vii, 110. Speusippus says that the πέρκη, χάννα and φυκίς are similar. Epicharmus calls them "gleaming." There was a proverb "The πέρκη follows the μελάνουρος." Aristotle says that the φυκίς is thorn-crowned and variegated in color, but the πέρκη belongs to those which are adorned with lines and have bands on their sides.

106. Serranus cabrilla (L.) H. Χάνος (2).

Apost. 17 (*Serranus cabrilla*), χάνος. Cf. χάννα and χάννη. Aristotle 598a 13, 591a 10 b 6, 1528a 15, 538a 19 21, 567a 27, 755b 21, 760a 9. Most of the fishes are male and female, but concerning the ἐρυθρῖνος and χάννη there is a doubt, for all of these which are caught have eggs in them. The χάνναι are purely carnivorous; they often throw out their stomachs (κοιλίας) when pursuing the smaller fishes, because the stomachs of fishes are near to their mouths and they have no gullet (στόμαχος). The χάννη is pelagic. Athen. vii, 134. Epicharmus in the Marriage of Hebe says: "Wide-gaping χάνναι and monstrous-bellied ὄνοι." Aristotle calls it (the χάννη), variegated with black and red (or salmon) and adorned with lines, because it is adorned with dark lines.

The names χάνος and χάννη mean the gaper, √ χαν, to gape.

107. Paracentropristis hepatus (L). H. * Καφομοῦλα (1).

Apost. 17 (*Serranus hepatus*), πέρκα.

108. Mycteroperca rubra (Bloch). H. * Μοσχακτάποδο (1).

Not noticed by Apostolides.

109. Epinephelus gigas (Brünnich.) H. Ῥοφός (1).

Apost. 18 (*Epinephelus gigas*), ῥοφός and † ὀρφώς. Aristotle 591a 11, 598a 10, 599b 6, 543b 1, 1530b 27. Aristotle has the forms ὀρφός and ὀρφώς. According to him this fish is of very rapid growth, is littoral, lies torpid for a season (in winter), and is purely carnivorous.

Aristophanes, Wasps, 493, speaks of the ὀρφοί as found in the markets of Athens.

Athen. vii, 97, *ὀρφώς* and *ὀρφός*. It is sharp-toothed and solitary. It is a peculiarity of it that the seminal ducts are not found in it and that it can live a long time after it is cut up. It is one of those which lie torpid during the stormiest days, and is more fond of being near land than out in the open sea. Numenius calls it the *very rough ὀρφός*. Cf. also Athen. viii, 51.

Aelian Nat. An. v, 18, says: The *ὀρφώς* is a sea fish, and if you should catch one and cut it up you would not see it dead immediately, but it still partakes of motion, and for no little time. They like to stay in holes throughout the winter. Cf. also Ael. Nat. An. xii, 1.

110. Epinephelus chrysotænia (Doderlein). H. *Στήρα* (1)

Not seen by Apostolides. Cf. Apost. 17, *Polyprion cernium.*

111. Polyprion cernium (Cuvier).

Apost. 17, *στήρα.*

112. Anthias anthias (L).

Apost. 18 (*Anthias sacer*).

Family **APOGONIDÆ.**

113. Apogon imberbis (L). H. *Καλογρίτσα* (1).

Apostolides 18 (*Apogon imberbis*). Cf. Apostolides 27, *Chromis castanea.*

Family **SPARIDÆ.**

114. Diplodus vulgaris (Geoffrey St. Hilaire). H. *Σαργός* (1), **σκαρογάϊδαρο*, (1), **ἀβλιάς* (1), *σπάρος* (1).

Apost. 23 (*Sargus vulgaris*), *σαργός*, †*χαρακίδα.* Aristotle *σάργος* (or v. l. *σαργός*), 543b 14 15 16, 570a 32 b 1 3, 543a 7 b 8, 591b 19 21, 1528a 24.

The *σάργος* spawns twice a year, in spring and in autumn; it is pregnant about thirty days in the month of December. The *σάργος*, *χελών*, *κέφαλος* and *σμύξων* (or *μύξων*) are different kinds of *κεστρεῖς*, i. e. sub-classes of the *κεστρεύς*. The *σάργος* feeds after the *τρίγλη*. The *σαργῖνοι* (sargus-like fishes?) run in schools. Athen. vii, 93, says that Aristotle says the spotted-tailed fishes are *μελάνουρος* and *σάργος*, and they are much lined and dark-lined. Num. in Hal. says: "To land, a *σαργός*, most 'line-jerking' of fishes." Lat. *sargus.* Plin. 9, 65 and 162. Ov. Hal. 105. *Σκάρος* and *σπάρος* are also

found in Aristotle. Vide sub *S. rondeletti* and *S. vetula*, Apostolides 23.

Σχαρογάϊδαρο is compounded of σχάρος and M. G. γάϊδαρο, donkey, and means *scarus-donkey*.

115. Diplodus sargus (Gmelin).

Apost. 23 (*Sargus rondeletti*), σπάρος.

The specimen sold me as σπάρος was *Diplodus vulgaris*. I am inclined to think that the names σαργός, σχάρος and σπάρος are used indiscriminately for any and all species of *Diplodus*.

Aristotle, 508b 17, has σπάρος, but a *vario lectio* is σχάρος. He says the σπάρος (or σχάρος if we follow the other reading) has many pyloric appendages. Athen. vii, 114, mentions the σπάρος and cites several passages from ancient writers in which the σπάρος is named. One is from Epicharmus, in which σπάρος can not be a mistake for σχάρος, as both names occur connected by and, viz., "We fished for σπάροι and σχάροι." Cf. also Athen. vii, 52.

116. Diplodus vetula (Cuv. & Val.).

Apost. 23 (*Sargus vetula*), † σχάρος cf. σχαρογάϊδαρο, *D. vulgaris*.

Σχάρος is common in ancient writers. Arist. 1531a 28, 621b 16, 1531a 10–17, 505a 28, 662a 7, 505a 14, 508b 11, 591a 14, 508b 12 17, 591b 22, 675a 3, 1528a 32, 621b 15.

According to Aristotle the σχάρος has two gills on each side, one single and the other double, has its stomach shaped exactly like an intestine, seems to ruminate just as the quadrupeds do, is a bony fish, is the only fish whose teeth are not sharp and pointed, and is consequently with good reason held to be the only one that ruminates.

Athen. vii, 113, under σχάρος, quotes Aristotle as saying that it is (not) sharp-toothed, and solitary and carnivorous; it has a small mouth and tongue, not grown fast much, etc. A passage plainly corrupt. To make any sense out of it at all we must assume that the negative near the beginning of the quotation has dropped out, and replace it. Otherwise it contradicts what Aristotle has repeatedly said elsewhere, and even contradicts the latter part of the passage itself, where it is said that the σχάρος is fond of seaweed and is baited with this.

The statement that the σχάρος chews its cud is made repeatedly in Aristotle and other ancient writers.

Nicander of Thyatira says there are two kinds of *σκάροι*, one of which is called *ὀνίας*, donkey-colored, the other *αἴολος*, brilliant.

This suggests *σκαρογάϊδαρο*, 'scarus-donkey,' a name given to one of my specimens of *Diplodus vulgaris*. Moreover the names secured by me under *D. vulgaris* indicate that at the present time the names *σκάρος*, *σπάρος* and *σάργος* are all used more or less indiscriminately for all the species of *Diplodus*.

Scarus is frequent in Latin writers. Plin. 9, 62. Ov. Hal. 9, 119. Hor. Sat. 2, 2, 22, etc.

117. Diplodus annularis (L).

Apostolides 23 (*Sargus annularis*), † *σουβλομύτης* at Corfu. *Σοῦβλα* (or *σουβλί*) = awl, spit (for roasting meat). *Μύτος* = thread. The resemblance to a derivation from these words may be accidental.

118. Charax puntazzo (Gmelin). H. *Οὔγαινα* (1).

Apost. 23 (*Charax puntazzo*), *οὔγαινα*, *οὔαινα*.

119. Pagellus erythrinus (L). H. *Λυθρίνι* (1), * *μπαλάς* (1).

Apost. 23 (*Pagellus erythrinus*), *λυθρίνι*, *λυθρινάρι*. For name *λυθρίνι* see under *Sparus pagrus*.

120. Pagellus acarne (Cuvier). H. * *Μούσμουλα* (1), *μουρμούρα* (1).

Apost. 24 (*Pagellus breviceps*).

121. Pagellus mormyrus (L). H. *Μουρμούρα* (2).

Apost. 24 (*Pagellus mormyrus*), *μουρμούρα*. A. G. *μόρμυρος*. Aristotle 570b 20.

Cf. Athen. vii, 94. Oppian, Hal. 1, 100, Latin *mormyr*. Ovid, Hal. 110. Plin. 32, 152. Ovid speaks of *Pictæ mormyres*, painted mormyrs.

There is frequent mention of the name, but apparently nothing that would help in identifying it.

122. Pagellus centrodontus (De La Roche).

Apost. 24.

123. Sparus pagrus (L). H. *Φαγγρί* (2), *λυθρίνι* (1).

Apost. 24 (*Pagrus vulgaris* and *Pagrus orphus*), † *μερτζάνι*, a Turkish word equivalent to the Greek *ἐρύθρινος*. Apostolides gives *φαγγρί* as common name for *Dentex macropthalmus*, and *λυθρίνι* for *Pagellus erythrinus*. *Φαγγρί* may be M. G. equivalent for A. G.

φάγρος. Aristotle 598a 13, 601b 30, 1529a 41, 1531a 37. The φάγρος alternates between the open sea and near the shore, has a stone in its head, and consequently suffers much in winter, is carnivorous, solitary, has a triangular heart, and is at its prime in spring.

Athen. vii, 133. Speusippus, in the second book of his "Resemblances," says the φάγρος, ἐρυθρῖνος and ἤπατος are similar.

Latin *Phager, phagrus, pager, pagrus;* hence, Spanish *Pargo,* English *Porgy,* corrupted to *Pogy.* Plin. 32, 150, 9, 57, 32, 113. Ovid. Hal. 107. See Bonitz's Index to Aristotle s. v. ἐρυθρῖνος, fin.

Under one of my specimens I noted that the tips of scales and ends of fins and tail were crimson.

Λυθρίνι is undoubtedly M. G. form of ἐρυθρῖνος. Λυθρίνι or λυθρινάρι (Apostolides, bottom of p. 23) = ἐλυθρίνιον or ἐλυθρινάριον, diminutive of ἐλυθρῖνος = ἐρυθρῖνος. The only possible question is on the last equation. The interchange of the liquids *l* and *r* is, however, a quite common phonetic phenomenon, though not, so far as I know, occurring elsewhere in passing from A. G. to M. G. Perhaps λύθρον, gore, is from ἐρυθρός and M. G. λυθριάζω = ἐρυθριάζω.

The fish ἐρυθρῖνος is frequently mentioned in Aristotle.

Aristotle, 538a 19–21, 567a 27, 598a 13, 741a 36,750b 30, 755b 20, 760a 8, 1511b 37, 1528b 1, 1529a 39.

According to Aristotle the ἐρυθρῖνος is a pelagic fish, and of both it and the χάννη the male had never been seen. He says the most of the fishes are male and female, but concerning the ἐρυθρῖνος and χάννη there is a doubt, for all which are caught have eggs in them. Again he says of those called ἐρυθρῖνοι no male has ever been seen, but only females, and these full of eggs. But we have not yet trustworthy observation on this point.

The name means red or reddish, and the color of the fish must have justified the name.

124. Sparus aurata (L). H. *Τσιππούρα* (1).

Apost. 24 (*Chrysophrys aurata* and *Chr. crassirostris*), † *χρυσόφα, τσιππούρα,* † *κόττσα* at Corfu, *μαρίδα* at Missolonghi. *Τσιππούρα* resembles somewhat the A. G. ἵππουρος, horse-tail, which Aristotle says has the most rapid growth of any fish. See Aristotle 543a 21 23, 599b 3. According to Cont. Lex. *τσίπουρα* is a

M. G. name for the refuse of grapes when the juice has been pressed out. For *μαρίδα* see *Smaris*.

Χρυσόφα is perhaps the A. G. *χρύσοφρυς*. Aristotle 598a 10, 591b 9, 489b 26, 508b 20 21, 543b 3, 570a 20, 598a 21, 537a 28, 599b 33, 602a 11. The *χρύσοφρυς* (literally "golden brow") has two fins on its back and two on its belly, has few pyloric appendages, one more and another fewer, is frequently speared in the day-time while sleeping, spawns chiefly where rivers flow, spawns in the summer, is littoral, is found in the lagoons of the sea, hibernates and suffers in winter.

Athen. iv, 13. Matro says: The *χρύσοφρυς*, which is the most beautiful among all fishes. Athen. vii, 136. A large and favorite food fish.

125. Spondyliosoma cantharus (Gmelin). H. **Σχαθάρι* (1).

Apost. 24 (*Cantharus griseus* and *C. brama*), † *ἀσκάθαρος*, † *βαγιοῦνο* in Corfu. *Σχαθάρι* is the common name for *Cantharus* among the men of the fish market. This is a clipped diminutive from *σκάθαρος*, *σχαθάρι(ον)*. Such diminutives are exceedingly common in the colloquial language of modern Greece, being diminutives in form only, and not in meaning.

In modern Greek *σκάθαρος* and *σκάνθαρος* means a beetle, just as ancient *κάνθαρος* (see Contopoulos Lex. s. v.). So also M. G. *σκάθαρος*, no doubt, equals ancient *κάνθαρος* as name of a fish. For initial *σ* cf. (*Σ*)*κάμανδρος* and (*σ*)*κέπαρνον* in Hom. where the fact that a short vowel is not read long before these words shows that they originally lacked the initial *σ*. Cf. also *κάπετος* for *σκάπετος*, *κνίφ'* and *σκνίφ'*, *κόνις* and M. G. *σκόνη*, *κύπτω* and M. G. *σκύπτω*, etc. Forms with and without initial *σ* before *μ* are common, as *μικρός* and *σμικρός*, *μῖλαξ* and *σμῖλαξ*, etc. For omission of the nasal before a mute cf. *γομφάρι* and *γοφάρι*.

Arist. 598a 10, speaks of the *κάνθαρος* as a littoral fish of solid flesh. According to Oppian it delights in rough rocks, Op. Hal. iii, 340.

126. Spondyliosoma orbiculare (Cuv. & Val.). H. **Σχαθάρι* (2), **σκάθαρος* (1).

Apost. 24 (*Cantharus orbicularis*). *Σχαθάρι* = A. G. *κάνθαρος*. See under *Spondyliosoma cantharus*.

127. Scatharus græcus (Cuv. & Val). H. *Σχαθάρι* (1).

Not noticed by Apostolides.

128. Box boops (L.). H. *Γύπα* (1).

Apost. 23 (*Box boops*), †*βῶπα* and *γοῦπα*. *Βῶξ* or *βόαξ*, now used as scientific name for this genus occurs in Aristotle 610b 4, 1528a 20. He says that they are found in schools. Those (?) marked on the back (*νωτόγραπτα*) are called *βῶξ*, but those marked obliquely (*σκολιόγραπτα*) are called *κολίας* (*σκολίας*). See Athenaeus vii, 27, where a number of references to the *βῶξ* are given from different authors. It was a favorite food fish. Athenaeus derives its name *βόαξ* from the word *βοή*, a cry or shout, and defends this form of the name and derivation against Aristophanes of Byzantium, who says: "We wrongly call the fish *βῶκα* (*βῶξ*), and ought to call it *βόωπα* (*βόωψ*), since being a little fish it has large eyes. It should be *βόωψ* = having the eyes of an ox." *βόωψ* is compounded of *βοῦς*, stem, *βο*(F) and *ὤψ*, and appears in Homer in the feminine form *βωῶπις* as a common epithet of Hera. The word means ox-eyed, large-eyed. If this is the fish now called *βῶπα* the authority of Aristophanes of Byzantium prevailed. At any rate, the *βῶξ* was a *small fish* with *large eyes*, having peculiar *markings on its back*, running *in shoals*, and admired by epicures.

129. Boops salpa (L). H. *Σάλπα* (1), *γόπα* (1).

Apost. 23 (*Box salpa*), *σάλπα*. Aristotle *σάλπη*. 1528a 4, 1531a 1 2 3, 534a 9, 621b 7, 598a 20, 570b 17, 543a 8, 543b 8.

The *σάλπη* has an especially acute sense of hearing, is enticed by malodorous bait such as dung, spawns in autumn in some places, but in most places in the beginning of summer, feeds on dung and seaweed, may be caught with pumpkin, spawns in the lagoons of the sea, is not carnivorous; it is much lined and red-lined, i. e. marked by many red (orange?) lines, has jagged teeth, and is solitary; it is best in harvest time. Athen. vii, 118. The *σάλπη* is variegated in color. Whence Mnaseas, who compiled the work entitled "Sports," was called *Σάλπη* by his acquaintances on account of the brilliant variety of the collection. There is a similar fish in the Red Sea called *στρωματεύς*, having golden bands extending across all its body as Philo reports in his "Metallicon."

130. Oblada melanura (L). H. *Μελανοῦρι* (1).

Apost. 23 (*Oblada melanura*), *μελανοῦρι*, black-tail. Aristotle 591a 15, 1528a 24, 1511b 37, 1512a 3, *μελάνουρος*. It feeds on sea-

weed. The *μελάνουρος* and *σαργός* are spotted on their tails (have a spot on their tails), and are much lined and dark-lined. Athen. vii, 93. Hicesius says it is like the *σαργός*.

Epicharmus mentions together *σαργίνοι* and *μελάνουροι*. Latin *Melanurus*, Ennius, Ovid., Plin., etc. Op. Hal. 1, 98.

There are many references which mention the *μελάνουρος*, but they add nothing to our knowledge of it. The meaning of the name so well describing the fish, and the fact that it is still in common use for this species establish its identity.

131. Dentex dentex (L). H. *Συναγρίδα* (2).

Apost. 24 (*Dentex vulgaris*), *συναγρίδα*. Aristotle *συναγρίς* (gen. *συναγρίδος*, acc. *συναγρίδα*). 505a 15, 506b 16. The *συναγρίς* has four single gills on each side, and the gall bladder on the entrails. Athen. vii, 121, *συναγρίδες*. Epicharmus mentions these in "Marriage of Hebe" and "Land and Sea."

132. Dentex macrophthalmus (Bloch).

Apost. 24 (*Dentex macrophthalmus*), *φαγγρί*. Cf. *Sparus pagrus*.

133. Mæna mæna (L).

Apost. 24 25 (*Mæna vulgaris, Osbeckii* and *Jusculum*, the two latter doubtful species).

134. Spicara smaris (L). H. *Μαρίδα* (1), * *μαίνουλα* (1), * *ξένουλα* (?) (1). * *μέλωνα* (1).

Apost. 25 (*Smaris vulgaris* and *Chrysalis*), † *σμαρίς*, † *μαρίς*. In M. G. *αι* = *ε*, so that *μαίνουλα* (*μένουλα*), *ξένουλα* and *μέλωνα* (*μέλουνα*) are evidently all modifications of the same name. *Μαρίδα* is the regular M. G. equivalent for A. G. *μαρίς* or *σμαρίς*. *Μαίνουλα* suggests *μαινίς*, found in Aristotle as name of a fish. 610b 4, 607b 10–21, 570b 15–30, 569b 28, 1529a 7, 607b 10. The *μαινίς* spawns after the winter solstice and is the most prolific of fishes. It is good when pregnant. The form of the female is rounder, that of the male longer and flatter. When the female is beginning to be pregnant the male is black and variegated in color. At this time they are called *τράγοι* (he-goats) by some. They run in schools. *Σμαρίς*, Aristotle 607b 22. The *σμαρίς* changes its color in like manner with the *μαινίς*, being lighter in winter and darker in summer. This is most evident around the fins and gills.

Op. Hal. 1, 109. Along the sedgy shore beneath the green plants feed *μαινίδες*, *τράγοι*, *ἀθερῖναι*, *σμαρίδες* and *βλέννος*, etc.

Epichar., frag. 35; Athen., vii, 92 and 137.

Speusippus says that the *βόαξ* and *σμαρίς* are like the *μαινίς*.

135. Spicara alcedo (Risso). H. * *Ζέρβουλλα.*

Apost. 25 (*Smaris alcedo*).

136. Centracanthus cirrus (Rafinesque).

Apost. 25 (*Smaris maurii*).

Family **PERCIDÆ.**

137. Perca fluviatilis (L).

Apost. 17 (*Perca fluviatilis*), † *πέστροφα.*

Family **MULLIDÆ.**

138. Mullus surmuletus (L). H. *Μπαρμπούνι* (Barbouni) (¸).

Apost. 15 (*Mullus surmulletus*) † *τρίγλες*, *μπαρβούνι*, *πετρόψαρο*, † *τσιγαρόλια.*

Apostolides identifies this with the ancient *τρίγλη*. Aristotle 1531a 26, 598a 10–21, 570b 22, 610b 5, 1531a 32, 621b 7, 1531a 32–33, 591a 12, 508b 17, 591b 19, 557a 26, 1531a 34, 621b 21, 1511b 39, 1512a 3, 570b 22–25, 543a 5, 1531a 24 33.

According to Apostolides the names *τρίγλες* and *μπαρμπούνι* are common to all species of the *Mullus*. *Μπαρμπούνι* is an Italian name. The same fish is common in both Italian and Greek markets under this same name. It is perhaps the same as the fish which the Romans called *Barbus*. Ans. Morell., 94, 134, cf. Cic. Par. 5, 2, 38, *Barbatulus mullus*, and id. Att. 2, 1, 7, *Barbati mulli*, bearded mullets.

According to Aristotle the *τρίγλη* (or *τρίγλα*) has many pyloric appendages, is the only fish that breeds three times a year, is especially infested with fish lice, feeds on sea-weed, shell-fish and mud; it lives near the shore, is found in the lagoons, runs in schools and eats flesh, but is not exclusively carnivorous.

Athen. vii, 125. The *τρίγλη* is sharp-toothed, gregarious, all spotted (?), and moreover carnivorous. When it has produced young (spawned) three times it is barren, for it gets little worms in its uterus which devour the eggs (or young *γόνος*). Speusippus says the *κόκκυξ*, *χελιδών* and *τρίγλη* are similar. They are called red-colored and yellow-colored.

Athenaeus gives many other references to the *τρίγλη*, but apparently they throw no light upon the identification of the fish.

139. Mullus barbatus (L).

Apost. 15 (*Mullus barbatus*), † *κεφαλάδες* at Chalcis.

140. Mullus fuscatus (Rafinesque).

Apost. 15.

Family **SCIÆNIDÆ.**

141. Umbrina cirrosa (L).

Apost. 18 (*Umbrina cirrosa*), *σκιός*, Cf. *Corvina nigra* = *Sciaena umbra.*

Aristotle has *σκίαινα* 601b 30. He says: "Those fish which have a stone in the head, as *χρώμις*, *λάβραξ*, *σκίαινα* and *φάγρος* suffer most in the winter. Athen. vii, 121, shows that the *σκίαινα* was also called *σκιαθίς* by Epicharmus and *σκιαδεύς* by Numenius.

Latin *Sciaena* and *Sciadeus* for the female and male respectively. Plin. 32, 151. *Σκιός* and *σκίαινα* both seem to be from *σκιά*, shadow; Latin, *Umbra.*

142. Sciæna aquila (Lac.).

Apost. 18 (*Sciæna aquila*), *μυλοκόπι*, † *κρανιός* at Chalcis.

143. Sciæna umbra (L). H. *Μυλοκόπι* (1), * *σαραβάνο* (1), *σκιός* (1).

Apost. 18, 19 (*Corvina nigra*), † *σκιὸς καλιακούδα.* According to Apostolides *μυλοκόπι* is common name for *Sciæna aquila.* For *σκιός* see *Umbrina cirrosa*, Apost. 18.

Family **LABRIDÆ.**

144. Labrus bergylta (Ascanius).

Apost. 25 (*Labrus bergylta*), *χελούδισες*, *χείλος*, *χειλοῦ*, † *φυκόψαρο* and *πετρόψαρο* M. G. names for the *Labrus. Φυκόψαρο*, = *φῦκος*-fish, may be referred to A. G. *φύκης* and *φυκίς.* The names are manifestly from *φῦκος*, sea-weed. Aristotle 567b 20 19, 591b 16, 607b 20, 1528a 10, 607b 18, 591b 13.

The small *φυκίδες* spawn twice a year, the male (*φύκης*) differs from the female (*φύκις*) by being darker and having larger scales. They feed upon the sea-weed (*φῦκος*), eat no flesh except that of the *καρίδες* (shrimps), change their color, being variegated in the spring but white during the rest of the year, and are the only sea-fishes which make a nest and lay their eggs in the nest. It

is a small fish, one of the rock-fish (*πετραῖοι*; observe M. G. name *πετρόψαρο*), crowned with spines, belongs to the *πετραῖοι* which are called soft-fleshed, such as the *κόσσυφοι*, *κίχλαι*, *πέρκαι*, *κώβιοι*, etc. For *χειλοῦ*, etc., see *Crenilabrus pavo*.

145. Labrus livens (L.) H. *Λάμπρινα* (1).

Apost. 25 (*Labrus merula*).

146. Labrus viridis (L). H. *Πετρόψαρο* (1), **συυλουμπαρδός* (1).

Apost. 25 (*Labrus viridis, etc.*). According to Apostolides all species of the genus *Labrus* are called by the names *χελούδισες*, *χεῖλος*, *χειλοῦ*, *φυκόψαρο* and *πετρόψαρο*.

147. Labrus bimaculatus (L.)

Apost. 25 (*Labrus mixtus*, etc.).

148. Symphodus ocellaris (L). H. **Καβώρας* (1), **σφίγγα* (1), sphinx.

Apost. 25 (*Crenilabrus roissali*).

149. Symphodus ocellatus (Forskål).

Apost. 25 (*Crenilabrus ocellatus*).

150. Symphodus mediterraneus (L). H. **Σελήνη* (1).

Apost. 26 (*Crenilabrus mediterraneus*). I can not find *σελήνη*, moon, given as name of a fish in any book, ancient or modern. The nearest approach is *συυλῆνα*, given by Cont. Lex. as common name of the bivalve *Ensis siliqua*, called razor-fish and spout-fish in English according to the Cent. Dictionary. The word *συυλῆνα* also means spout-fish, being from ancient *σωλήν*, a spout or gutter.

This name is used by the ancients as name of a bivalve, and this is no doubt the same as is now called *συυλῆνα*. See Aristotle 683b 17, 528a 17 22, 548a 5, etc.

151. Symphodus tinca (L). H. **Χειλοῦσα* (2), *χειλοῦ* (1).

Apost. 26 (*Crenilabrus pavo*), †*λήπαινα*, †*λαπίνα μαύρη* (black) and *μεγάλη* at Chalcis.

Χεῖλος means lip, Latin *labrum*, whence the name *Labrus*. Apostolides gives *χεῖλος* and *χειλοῦ* as common name of *Labrus* in all species. *Χειλοῦσα* is clearly the same as *χειλοῦ*. My three specimens were obtained on different occasions and probably from different parties, making it evident that *χειλοῦ* is used for *Symphodus* as well as for *Labrus*.

152. Symphodus melops (L).

Apost. 25 (*Crenilabrus melops*).

153. Symphodus cinereus (Bonnaterre).

Apost. 25 (*Crenilabrus massa*).

154. Symphodus melanocercus (Risso).

Apost. 25 (*Crenilabrus cœruleus*).

155. Symphodus scina (Forskål).

Apost. 26 (*Coricus rostratus*).

156. Ctenolabrus suillus (L). H. * *Κατραβάνος* (1).

Apost. 26 (*Ctenolabrus rupestris*).

157. Julis julis (L). H. * *Ταντάνο* (1).

Apost. 26 (*Julis vulgaris* and *J. giofredi*), † *γόλος*. According to Apostolides this is the ancient *ἴουλος*. Aristotle 610b 6 gives *ἰουλίς* (Latin *Julis*) as name of a fish found in schools; *ἴουλος* = down, hair, beard; also a centipede. Cf. Athen. vii, 70 and 20.

158. Thalassoma pavo (L).

Apost. 26 (*Julis pavo*), † *γαϊτανοῦρι*, † *φιάμουλα* at Patras, and † *γραβανάς* at Trikeri. *Γαϊτάνι* is a Turkish word meaning a silken cord, a string (Cont. Lex.). *Γαϊτανοῦρι* would accordingly mean string-tail.

159. Xyrichthys novacula (L).

Apost. 27 (*Xyrichthys novacula*), † *κατεργάρος* and † *κτένι*, according to locality. The former means rogue, one condemned to work in the galleys (*κάτεργα*). *Κτένι* is M. G. for A. G. *κτεὶς* (gen. *κτενός*), a comb. *Κτείς* in A. G. was used as name of a bivalve, a cockle or scallop, often mentioned in Aristotle. According to Cont. Lex. the modern *κτένι* is used in same way, the sea comb.

Family **POMACENTRIDÆ.**

160. Chromis chromis (L). H. * *Σκαθάρι* (1).

Apost. 27 (*Chromis castanea*), † *καλόγρηα* and *καλογρίτσα*. *Καλόγρηα* means a nun. *Καλογρίτσα* would seem to be another form for the same, although the lexicon (Cont. Lex.) gives it as meaning tomtit. *Σκαθάρι* is probably a mistake here, the man who sold it me supposing it to be *Cantharus*.

Family **TRACHINIDÆ.**

161. Trachinus draco (L). H. *Δράκαινα* (2).

Apost. 13 (*Trachinus draco*). According to Apostolides *δράκαινα* is common name for all species of the genus *Trachinus*. In A. G. *δράκαινα* is feminine of *δράκων*, a serpent or dragon. The kindred word *δρακαινίς*, also a feminine of *δράκων*, occurs as name of a fish in a fragment of the comic poet Ephippus, who flourished in the early part of the Fourth century, B. C. Also in a fragment of Mnesimachus. Aristotle 598a 11 uses *δράκων* as name of a fish which lives near the shore (i. e. a littoral fish). A fragment of Epicharmus also contains *δράκων* as name of a fish. Vide Athen. vii, 28.

162. Trachinus vipera (Cuv. & Val).

Apost. 13.

163. Trachinus araneus (Cuv. & Val).

Apost. 13.

164. Trachinus radiatus (Cuv. & Val).

Apost. 13.

Family **URANOSCOPIDÆ.**

165. Uranoscopus scaber (L). H. *Λίχνος* (1).

Apost. 13 (*Uranoscopus scaber*), *λίχνος*, *λοῦτσος* and † *κοῦκος*. Identified in Apostolides with the *καλλιώνυμος* of Aristotle. For *καλλιώνυμος* see Aristotle 598a 11, 506b 10, 1529b 9.

According to Aristotle the *καλλιώνυμος* it a littoral fish with the gall on the liver, and has the largest gall-bladder of any fish in proportion to the size of the fish.

Aelian, N. A. 134, says: "Concerning it (the fish called *καλλιώνυμος*) Aristotle says that it has a large gall-bladder attached to the right lobe of the liver, and that it carries its liver in its left side."

According to Athenaeus, vii, 16 and 17, there seems to have been considerable confusion among the names *ἀνθίας*, *καλλίχθυς*, *καλλιώνυμος* and *ἔλοψ*." Pliny says (32, 146): Callionymus or Uranoscopus. (32, 69). The same fish (Callionymus) is also called *Uranoscopus* (sky-gazer), from the eye which it has in its head. Athen. viii, 52. *Οὐρανοσκόπος* and the one called *ἄγνος*, or also *καλλιώνυμος*, are heavy as food. Cf. A. G. *κόκκυξ*, sub. *χελιδονόψαρο* (*Dactylopterus volitans*).

Family **CEPHALACANTHIDÆ.**

166. Cephalacanthus volitans (L). H. *Χελιδονόψαρο* (1), swallow-fish.

Apostolides 15 (*Dactylopterus volitans*), *χελιδονόψαρο*. Apostolides identifies this with the *κόκκυξ* of Aristotle. But may it not be the sea *χελιδών* spoken of by Aristotle 535b 27? He says: "The *κτένες* when they rush along, resting upon the water (which people call flying), make a whizzing sound, and the sea swallows (*αἱ θαλάττιαι χελιδόνες*) do the same, for these fly in the air not touching the water."

Cuvier identifies this sea swallow with *Dact. volitans*. Compare, however, *Trigla hirundo*, still called *χελιδόνα*, the swallow.

Of the *κόκκυξ*, cuckoo, Aristotle (598a 15 and 535b 20) says: "It makes a sound like the cuckoo, whence it gets it name." The *κόκκυγες* are both pelagic and littoral (alternately). Vide Plin. Hirundo, 9, 82 and 32, 149. Athen. vii, 84.

There is nothing in any reference that I can find to show that the *κόκκυξ* was a *flying* fish. According to Apostolides 13 *Uranoscopus scaber* is called *κοῦκος*, M. G. for cuckoo. May not this be *κόκκυξ*?

Family **TRIGLIDÆ.**

167. Peristedion cataphractum (L). H. **Κερατόψαρο* (1), horn-fish.

Apost. 16 (*Peristethion cataphractum*), *καπώνη*.

Two specimens sold me under the name *καπώνη* in the market at Athens turned out to be *Trigla lineata* and *Trigla lyra*.

168. Trigla lineata (Gmelin). H. *Καπώνη* (1).

Apost. 16 (*Trigla lineata*).

169. Trigla cuculus (L).

Apost. 16 (*Trigla pini*).

170. Trigla milvus (Lacépède).

Apost. 16 (*Trigla cuculus*).

171. Trigla gurnardus (L).

Apost. 16.

172. Trigla lyra (L). H. *Καπώνη* (1).

Apost. 16 (*Trigla lyra*).

173. Trigla hirundo (Bloch). H. *Χελιδόνα* (1).

Apost. 16 (*Trigla corax*).

Χελιδόνα is M. G. for A. G. *χελιδών*, swallow. Aristotle 535b 27. The sea swallows (*αἱ θαλάττιαι χελιδόνες*) fly in the air, not

touching the sea, for they have their fins broad and long. See *Cephalacanthus volitans*, called *χελιδονόψαρο*. Cf. also ***Myliobatis bovina***, Apostolides 9.

174. Lepidotrigla cavillone (Lacépède).

Apost. 16 (*Trigla cavillone*).

Family **SCORPÆNIDÆ.**

175. Scorpæna scrofa (L.) H. *Σκορπιός* (2).

Apost. 16 (*Scorpæna scrofa*), † *σκορπίνα*. According to Apostolides *σκορπιός* is common name of *S. porcus*. *Σκορπίος* = scorpion. As name of a fish Aristotle, 1531a 20, 508b 17, 593a 7, 598a 14. It has many pyloric appendages, breeds (spawns) twice a year, alternates between the open sea and the shallow water along the shore; the *σκορπίδες* breed in the open sea (*τὸ πέλαγος*).

Athen. vii, 115. Num. "Red *σκορπίος*." Hicesius says: "Of the *σκορπίοι* one kind is pelagic the other littoral; the former is a fiery red, the latter blackish. Epicharmus calls the *σκορπίος ποικίλος*, variegated. It is solitary and eats seaweed. Aristotle mentions *σκορπίοι* and *σκορπίδες* in different places. It is not clear whether he means the same fish by these two names. That we have frequently eaten both *σκόρπαινα* and *σκορπίοι* and that the flavors and colors are different, no one is ignorant. Archestratus, in his "Golden Words," says: "Buy the small *σκορπίος*, but beware of a big one." Athen. viii, 52. The tawny, pelagic *σκορπίοι* are more nutritious than the large ones of the shoal water near shore.

176. Scorpæna porcus (L).

Apost. 16 (*Scorpæna porcus*), *σκορπιός* and † *χάφτης*.

Family **CALLIONYMIDÆ.**

177. Callionymus festivus (L). H.

Not noticed by Apostolides.

Family **GOBIIDÆ.**

178. Gobius niger (L).

Apost. 15.

179. Gobius jozo (L). H. *Κωβιός* (3).

Apost. 14 (*Gobius jozo*), *κωβιός*, † *γωβιός*. According to Apostolides *κωβιός* and *γωβιός* are common names for all species of the

genus *Gobius*. Aristotle κωβιός, 610b 4, 598a 11 16, 508b 16, 569b 23, 621b 13 19, 567b 11, 591b 13, 601b 22, 835b 14. The κωβιός has many pyloric appendages above the stomach, spawns near the land on the rocks, the bunches of eggs are flat and crumbling; it feeds on mud, sea-weed, sea-moss, etc.; lives near the land, gets fat in the rivers, and is found in schools. The white κωβιός, found in the Euripus of Lesbos. never leaves that lagoon for the open sea as the other fishes found there do. Latin *Gobio* and *Cobio*, Plin. *Gobius*, Ovid., Hal. 12, 8. Martial 13, 88.

180. Gobius guttatus (Cuv. & Val).

Apost. 14.

181. Gobius auratus (Risso).

Apost. 14.

182. Gobius paganellus (L).

Apost. 14.

183. Gobius cruentatus (Gmelin).

Apost. 14.

184. Gobius capito (Cuv. & Val).

Apost. 14.

185. Gobius minutus (L).

Apost. 14 (*Gobius quadrimaculatus*).

Family **BLENNIIDÆ.**

186. Blennius pavo (Risso). H. * *Παπαγάλος* (1), an Italian word meaning parrot.

Apost. 13 (*Blennius pavo*), † *σαλιάρες*.

187. Blennius sanguinolentus (Pallas).

Apost. 13.

188. Blennius gattorugine (Bloch).

Apost. 13 (*Blennius gattorugine*), † *σαλιάρα*, slobbering.

189. Blennius ocellaris (L).

Apost. 14.

190. Blennius pholis (L).

Apost. 14.

191. Blennius trigloides (Cuv. & Val).

Apost. 14.

192. Blennius galerita (L).

Apost. 14 (*Blennius montagnei*).

193. Cristiceps argentatus (Risso). H. *Γῶπα* (1).

Apost. 14 (*Clinus argentatus*). For *γῶπα* see *Box*.

194. Tripterygiou tripteronotus (Risso).

Apost. 14 (*Tripterygion nasus*).

Family **OPHIDIIDÆ.**

195. Ophidion vassalli (Risso). H. **Γιλάρι* or **χιλάρι* (1).

Apost. 28 (*Ophidium vassali*). *Χιλάρι* may be a diminutive from *χεῖλος*, lip.

196. Ophidion barbatum (L).

Apost. 28.

Family **GADIDÆ.**

197. Gadus callarias (L).

Apost. 28 (*Gadus morrhua*, the young of *G. callarias*). † *Μουρούνα* at Chalcis. Rare, according to Apostolides, but the identification must be doubtful.

198. Phycis phycis (L). H. **Ποντίκι* (1).

Not seen by Apostolides. *Ποντίκι*, M. G. for mouse. Cf. Aristotle, *ὁ ποντικὸς μῦς*, 600b 13, 632b 9.

199. Pollachius poutassou (Risso). H. **Τσιπλάκι* (1).

Apost. 29 (*Merlangus poutassou*), †*γαϊδουρόψαρον*.

The name *γαϊδουρόψαρον* is modern, meaning donkey-fish. *Γαΐδουρος* = *γάδαρος* = ass, donkey. The ancients called a certain fish *ὄνος*, ass. Dorio, in Athenaeus vii, 99, says some persons call the *ὄνος* (i. e. the fish *ὄνος*) *γάδος*. Epicharmus in his Marriage of Hebe says: "Wide-gaping *χάνναι* and monstrous-bellied *ὄνοι*." See Aristotle 599b 33, 601a 1, 620b 29, frag. 307, 1530a. According to Aristotle the *ὄνος* has a mouth opening wide (lit. breaking back), like the *γαλεοί*. It leads a solitary life, is the only fish which has its heart in its belly, has stones in its brain like mill-stones in form, and is the only fish which lies torpid in the warmest days under the

reign of the dog-star, Sirius, the other fishes going into this torpid state in the wintriest days. The *ὄνος*, *βάτος*, *ψῆττα* and *ῥίνη* bury themselves in the sand and after they make themselves invisible they wave the things in their mouths which fishermen call little rods or little wands (*ῥαβδία*).

200. Merluccius merluccius (L). H. *Μπαχαλάρο* (1).

Apost. 29 (*Merlucius vulgaris*), *μπαχαλιάρος*. Cont. Lex. *μπαχαλάος*. Turkish word meaning stock-fish. *Μπαχάλης* (Turk) = grocer. Also written *βαχαλάος* and *βαχάλης*.

201. Mora moro (Risso).

Apost. 29 (*Mora mediterranea*).

202. Molva elongata (Otto).

Apost. 29 (*Lota elongata*).

Family **PLEURONECTIDÆ.**

203. Pleuronectes flesus (L).

Apost. 29 (*Flesus passer*).

204. Psetta maxima (L).

Apost. 30 (*Rhombus maximus*), † *χαλκάνι*.

205. Bothus rhombus (L).

Apost. 30 (*Rhombus lævis*).

206. Platophrys podas (De la Roche). H.

Apost. 30 (*Pleuronectes candidissimus* and *Bothus rhomboides*).

207. Eucitharus linguatula (L). H. *Γλῶσσα* (2).

Not noticed by Apostolides. For *γλῶσσα* see under *Solea solea*.

208. Solea theophila (Risso).

Apost. 29 (*Solea lascaris*).

209. Monochirus variegatus (Donovan).

Apost. 30 (*Microchirus variegatus*).

210. Monochirus hispidus (Rafinesque). H. * *Καψώρα*.

Not recorded by Apostolides.

211. Monochirus ocellatus L.

Apost. 29 (*Solea oculata*).

212. Solea solea (L). H. *Γλῶσσα* (1).

Apost. 29 (*Solea vulgaris*), *γλῶσσα*, tongue. † *Χωματίδα* at Nauplia and Missolonghi. I found *γλῶσσα* a common name for any kind of sole. Ancient writers used *βούγλωσσος*, ox-tongue, as name of a kind of fish. The name is quoted by Athenaeus from various writers. Athen. iv, 13, Matro. "A *βούγλωσσος* which dwelt in the foaming brine (sea)" Vii, 30. "The roughish *βούγλωσσος*." The *κυνόγλωσσος* (dog-tongue) differs from the *βούγλωσσος*. The Attics call it *ψῆττα*. Vii, 139. Speusippus says that the *ψῆττα*, *βούγλωσσος* and *ταινία* are similar. *Βούγλωσσος*, *ψῆττα* and *μῦς* are given at the end of a list of fishes, the list being quoted from Aristotle. Dorio names *βούγλωσσος* and *ψῆττα* as belonging to the *flat* fishes. The Romans call the *ψῆττα* *βόμβος*, which is also a Greek name. Oppian Hal., i, 99.

It is plain from the above that the *βούγλωσσος* and *ψῆττα* were much alike, if not the same.

Family **BALISTIDÆ.**

213. Balistes carolinensis (Gmelin).

Apost. 12 (*Balistes capriscus*), † *μονόχοιρος*, lone-pig.

Family **MOLIDÆ.**

214. Mola mola (L).

Apost. 11 (*Orthagoriscus mola*).

215. Ostracion trigonus (L).

Apost. 12.

A West Indian species, said by Apostolides to have been taken at Skiathos, which is probably an error.

Family **LOPHIIDÆ.**

216. Lophius piscatorius (L). H. **Πεσχανδρίτζα* or **πεσχαντρίτζα* (2).

Apost. 14 (*Lophius piscatorius*). Probably of Italian origin, meaning fisher. † *Χλάσκα* at Chalcis, † *σκλεμποῦ* and † *βατραχόψαρο* at Patras. The *βάτραχος ὁ ἁλιεύς* (the fisher frog) of Aristotle. See Aristotle 505a 6 b 4, 506b 16, 564b 18, 565b 29, 570b 30, 620b 11 ff, 695b 14, 696a 27, 749a 23, 754a 23 ff, 755a 9, 835b 13, 1527b 41–43, 540b 18.

Aristotle says with regard to the *βάτραχος*: "Inasmuch as the flat front part is not fleshy, nature has compensated for this by

adding to the rear and the tail as much fleshy substance as has been subtracted in front." The *βάτραχος* is called the angler. He fishes with the hair-like filaments hung before his eyes. On the end of each filament is a little knob just as if it had been placed there for a bait. He makes a disturbance in sandy or muddy places, hides himself and raises these filaments. When the little fishes strike at them he leads them down with the filaments until he brings them to his mouth. The *βάτραχος* is one of the *σελάχη*. All the *σελάχη* are viviparous or ovoviviparous except the *βάτραχος*. The other flat *σελάχη* have their gills uncovered and underneath them, but the *βάτραχος* has its gills on the side and covered with skinny opercula, not with horny opercula like the fish which are not *σελαχώδη*. Some fishes have the gall bladder upon the liver, others have it upon the intestine, more or less remote from the liver and attached to it by a duct. Such are *βάτραχος*, *ἔλλοψ*, *συναγρίς*, *σμύραινα* and *ξιφίας*. (Proved true of *Lophius piscatorius* by a dissection by Dr. C. H. Gilbert.) The *βάτραχος* is the only one of the *σελάχη* which is oviparous. This is on account of the nature of its body. For it has a head many times as large as the rest of its body, and spiny and very rough. For this same reason it does not afterwards admit its young into itself. The size and roughness of the head prevents them both from coming out (i. e. being born alive) and from going in (being taken into the mouth of the parent). The *βάτραχος* is most prolific of the *σελάχη*, but they are scarce because the eggs are easily destroyed, for it lays them in a bunch near the shore.

INDEX OF GREEK TERMS.

'Αβλεννής 249
ἀβλιάς 261
ἄγνος 272
ἀγριόψαρο 234
ἀετός 239
ἀθερίνα 252, 253
ἀθερίνη 252, 268
ἀθερῖνος 252
ἀχανθίας γαλεός 235
ἀλογάκι 249
ἀλωπεκίας 235
ἀλώπηξ 235, 238
ἀμία 257
ἀνθίας 272
ἀσκάθαρος 265
ἀστερίας 235
αὐλοί 233, 238
αὐξίδες 255, 257
ἀφαρεύς 255
Βαγιοῦνο 265
βατί 237
βατίον 237
βατίς 238
βάτος 235–239, 277
βάτραχος . 278, 279, 231, 239,
. . . . . 240, 241
βατραχόψαρο 278
βελάνισες 251
βελόνη . . 249, 251, 253, 257
βελόνι 249
βελονίδα 249
βελονίδι 249
βλέννος 251, 268
βόαξ 266, 268
βούγλωσσος 278
βοῦς 239
βόωψ 266
βρύον 241
βῶξ 266
βῶπα 266
Γάδαρος 276
γάδος 276
γάϊδουρος 276
γαϊδουρόψαρο 276
γαϊτανοῦρι 271
γαλῆ 234
γαληός 234
γαλεοειδής . . 234, 235, 238
γαλεός . . . 233, 234, 235,
. . . 238, 239, 276
γαλία 234
γαλεώδης . . 234, 235, 237,
. . . . . 238, 239
γάστρος 252
γάτος 233
γαῦρος 244
γιλάρι 276
γκιφάρι 257
γλαβίτσα 244
γλάνις . . . 241, 242, 259
γλανός 241
γλαῦκος 247
γλουπέας 256
γλῶσσα 277, 278
γοβύλι 250
γόγγρος . . . 246, 247, 248
γομφάρι 257, 265
γομφάριον 257, 258
γόμφος 257, 258
γύπα 266
γουλιανός 241
γοῦπα 266

γουρουνόψαρο 236
γουφάρι 257, 258
γοφάρι 258, 265
γόφος 256
γραβανάς 271
γύλος 271
γωβιός 274
γῶπα 276
Δράκαινα 272
δρακαινίς 272
δράκων 272
δρόγγα 246
Ἐγχελοτρόφοι 245
ἐγχέλυς . . 244, 245, 246, 247, ... 248
Ἕλοψ 272, 279
ἐρίτιμοι 242, 243
ἐρυθρῖνος . 247, 260, 263, 264
Ζαλοὔπαρδος 246
ζαργάνα 249
ζέρβουλλα 268
ζύγαινα 234
Ἥπατος 264
Θαλάττιαι χελιδόνες . . . 273
θαλάττιοι ὄφεις 247
θόρος 245
θρίσσα 242, 243
θύννα 254
θύννη 257
θυννίς . . 254, 255, 256, 257
θύννος . . 254, 255, 256, 257
Ἰλιακας 254
ἴλιος 254
ἰουλίς 271
ἴουλος 271
ἱπποκάμπιον 250
ἱππόκαμπος 249, 250
ἵππουρος 264
Καβώρας 270
καλκάνι 236, 277
καλλίχθυς 272
καλλιώνυμος 272
καλόγρηα 271
καλογρίτσα 261, 271
κάμπη 250
κάμπος 250
κάνθαρος 265
κανῆκι 234
καπώνη 273
κάραβος 246
καρίς 269
καρχαρίας 233, 234
κάρχαρος 234
κατεργάρος 271
κατουρλίδα 250
κατραβάνος 271
κατρολίδρα 250
κάττα 233
κάτος 233
κάττος 233
καψομοῦλα 260
καψώρα 277
κεντρίνης 235
κέππα 242
κερατόψαρο 273
κέρκος 237
κέστρα 253, 257
κεστρεύς . . 252, 258, 261, 237, ... 246, 247, 251
κεφαλάδες 252, 269
κέφαλος . . 250, 251, 252, 261
κίχλη 241, 259, 260
κοιλία 245, 260
κοκάλι 257
κοκάλιον 257
κόκκινος 242
κοκκινόψαρο 242
κόκκυξ . . 247, 268, 272, 273
κολίας 243, 254, 266
κολιός 254

κόπανος 256
κορδύλη 257
κορδύλος 241
κόττυφος 260
κότσα 264
κοῦκος 272
κουλαγοῦζος 257
κρανιός 269
κροσταλῆδα 259
κτείς 271, 273
κτένι 271
κύημα 241, 246
κυνόγλωσσος 278
κυπρῖνος 241, 260
κύων 235, 238
κωβιός 251, 274, 275
κωβῖτις 243
Λαβράκι 259
λάβραξ 259, 269
λαγιάδες 251
λαγώς 251
λάμια 233, 239
λαμπουγα 253
λάμπρινα . . . 270, 232, 242
λαπίνα 270
λειόβατος . . 235, 236, 238
λεῖος 235
λεπίδες 246
λευκόνος 252
λήπαινα 270
λίτσα 257
λίχνος 272
λουτζος 253
λουτσος 272
λουφάρι 257
λυθριάζω 264
λυθρινάρι 263, 264
λυθρίνι 263, 264
λύθρον 264
Μαϊατικό 256
μαινίς 267, 268
μαίνουλα 267
μανάλια 253
μαρίδα 264, 267
μαρίς 267
μαυράκι 252
μελανοῦρι 266, 267
μελάνουρος . 260, 261, 266, 267
μέλωνα 267
μεμβράδες 243
μερτζάνι 263
μονόχειρος 278
μονόχοιρος 278
μόρμυρος 263
μοσχαχτάποδο 260
μουγγρί 246
μουδιάστρα 236
μουρμούρα 263
μουρούνα 276
μούσμουλα 263
μούτρουβα 240
μπαχαλάρο 277
μπαχαλιάρος 277
μπάλας 263
μπαρμπούνι 268
μπάφες 250
μυλοκόπι 269
μυξινάρι 252
μυξῖνος 252
μύξων 252, 261
μύραινα 246, 247, 248
μῦρος 248
μῦς 276, 278
Νάρκη 235–239
νηστις 251
νεβρίαι γαλευί . . . 235, 238
Ξένουλα 267
ξιφίας 253, 255, 279
ξιφιός 253
Οἰσόφαγος 246

οἶστρος 253, 255
ὀνίσχος 248
ὄνος . 277, 236, 238, 260, 276
ὀξύρυγχοι ῥαφίδες . . . 250
ὀρκύς 256
ὀρκύνος 256, 257
ὀρφός 246, 260, 261
ὀρφώς 260, 261
οὔαινα 263
οὔγαινα 263
οὐρανοσκόπος 272
ὄφις 247
Παλαμύδα 256
παπαγάλος 275
παππαλίνα 243
πατερίτσα 234
πελάγιοι 247
περαίας 252
πέρκα 259
πέρκη 241, 259, 260
πεσκανδρίτσα 278
πέστροφα 244, 268
πετραῖοι 238, 260
πετρόψαρο . . . 268, 269, 270
πηλαμύς . . 254, 255, 256, 257
πλαταρίδα 252
πλατίτσα 242
πλεκτάνας 246
ποικίλος 235
πολύποδες 246
ποντίκι 276
Ῥαβδεύεται 238
ῥαβδία 238, 277
ῥαφίς 249, 250
ῥάχις 239
ῥίνα 236
ῥίνη 236–239, 277
ῥινόβατος 236, 238
ῥόμβος 278
ῥυφός 260
Σαινπιέρης 258
σαχχοράφα 250
σαλιάρα 275
σαλιάρες 275
σάλπα 266
σάλπη 266
σαμπανιός 257
σαμπχέρο 258
σανπιέρος 258
σαραβάνο 269
σαργάνα 249
σαργῖνος 249, 261, 267
σαργός . . . . 249, 252, 261, ... 262, 263, 267
σάρδα 243
σάρδη 243
σαρδήνη 243
σαρδέλα 243
σαρδώ 243
σαρδελομάνα 242
σαρδῖνος 243, 249
σαυρίδι 257
σαυρίδι κυνηγός 257
σαυρίς 253, 257
σαῦρος 257
σέλας 240
σελάχη . 234–239, 240, 247, 279
σελάχι 238
σελάχια 240
σελαχώδης . 238, 239, 240, 279
σελήνη 270
σκαθάρι 265, 271
σκάθαρος 265
σκάνθαρος 265
σκαρμός 244
σκαρογάϊδαρο . . 261, 262, 263
σκάρος . . 246, 261, 262, 263
σκάρος αἰόλος 263
σκάρος ὀνίας 263
σκιαδεύς 269

σκιαθίς 269
σκίαινα 269
σκιός 269
σκιός καλιακούδα 269
σκλεμποῦ 278
σκυλίας 266
σκομβρί 254
σκόμβρος . . . 254, 255, 256
σκόνη 265
σκορδόλαι 255, 257
σκόρπαινα 274
σκόρπινα 274
σκορπιός 247, 274
σκορπίος ποικίλος 274
σκορπίς 274
σκουμβρί 254
σκύλαξ 233
σκυλίον 233, 235, 238
σκυλί 233
σκύλλα 233
σκυλόψαρο 233, 234
σκύμνος 235
σκύπτω 265
σμαρίς 267, 268
σμέρνα 247, 248
σμύξων 252, 261
σμύραινα . . . 247, 248, 279
σμύρενα 247
σμῦρος 248
σορσόλλα 236
σουβλομίτης 263
σουβλομυτάρι 244
σουλῆνα 270
σουλούμπαρδος 270
σπαθόψαρο 254
σπάρος 261, 262, 263
στήρα 261
στειράδια 250
στόμαχος . . . 244, 246, 260
στουριόνι 241
στρωματεύς 266
συναγρίδα 267
συναγρίς 267, 279
σφίγγα 270
σφύραινα 253
σωλήν 270
Ταινία 278
ταντάνο 271
τονίνα 254
τράγοι 267, 268
τρίγλες 268
τρίγλη 261, 268
τριχίας 242, 243
τριχιός 243
τριχίς 242, 243
τρυγών . . 235–239, 240, 247
τσῆρος 254
τσιγαρόλια 268
τσιπλάκι 276
τσίπουλα 259
τσιππoῦρα 264
τυφλίναι 249
Ὑπόζωμα . . . 230, 233, 235, 239, 240
ὑστέρα 235
Φαγγρί 263, 267
φάγρος 247, 264, 269
φιάμουλα 271
φίδι τῆς θαλάσσης . . . 247
φίσσα 242, 243
φρίσσα 242, 243
φύκης 269
φυκίς 260, 269
φυκόψαρο 269, 270
φωλοῦσιν 246
Χαλκίδες 242, 243
χάννα 260
χάννη . . . 247, 260, 264, 276
χάνος 260
χαραχίδα 261

χάφτης 274
χαφί 244
χεῖλος 269, 270
χειλοῦ 269, 270
χειλοῦσα 270
χέλι 244
χελιδόνα 240, 273
χελιδονόψαρο . . 249, 273, 274
χελιδών 268, 272, 273
χελούδισες 269, 270
χελών 251, 252, 261
χελώνια 252
χιλάρι 276
χλάσκα 278
χοῖρος 236
χονδραχάνθα 239
χριστόψαρο 258
χρόμις 269
χρυσόφα 264, 265
χρύσοφρυς 265
χρυσόψαρο 242
χωματίδα 278
Ψαθυρὸν ᾠόν 246
ψῆττα . . 236, 238, 277, 278

JULY 5.

The President, GENERAL ISAAC J. WISTAR, in the chair.

Fifty-four persons present.

JULY 12.

Mr. CHARLES MORRIS in the chair.

Fifteen persons present.

JULY 19.

Mr. CHARLES MORRIS in the chair.

Eleven persons present.

JULY 26.

Mr. BENJAMIN SMITH LYMAN in the chair.

Six persons present.

AUGUST 2.

Mr. CHARLES MORRIS in the chair.

Ten persons present.

AUGUST 9.

Mr. CHARLES MORRIS in the chair.

Nine persons present.

AUGUST 16.

Mr. CHARLES ROBERTS in the chair.

Seventeen persons present.

AUGUST 23.

Mr. CHARLES ROBERTS in the chair.

Eleven persons present.

A paper entitled "Autosporadic Seeds in Oxalis stricta," by Ernest Walker, was presented for publication.

The death of Edw. C. Knight, a member, July 21, 1892, was announced.

AUGUST 30.

Mr. CHARLES MORRIS in the chair.

Nineteen persons present.

William Bringhurst, M. D. was elected a member.

Carlos Berg, of Buenos Aires, was elected a correspondent.

The following was ordered to be printed:—

THE AUTOSPORADIC SEEDS OF OXALIS STRICTA.

By Ernest Walker.

The effective method this plant has of scattering its mature seeds, in which it proves to be a decided "touch-me-not" seems hitherto to have escaped observation. In Gray's Manual, and other like works, the seeds are spoken of as having a "loose and separating" coat, but the part this envelope plays in dehiscence and in the distribution of the species is not mentioned.

In May, 1891, I made some careful observations, and the following memoranda:—

As the seeds of *Oxalis stricta* L. attain maturity, the erect loculicidal capsule becomes flaccid. In this condition the least disturbance, as the touch of the hand or shaking by the wind, causes the seeds to be expelled with considerable force, and thrown two or three feet. Sitting for a few minutes by a plant, the tick of the seeds as they were continually projected could be distinctly heard. To place a capsule in the palm of the hand, and press it, suggested the bursting of pop-corn.

The shooting of the seed was done so quickly that it was some time before I could make out the manner in which it was accomplished.

The active agent is the outer coat of the seed. This consists of a translucent, shining, membraneous envelope stretched tightly over the seed. When it bursts, it suddenly and elastically turns inside-out; after which it becomes flaccid.

This coat is thicker in a line along the ventral margin of the pendulous seed, or along the edge which is next the axis of the capsule. The rupture is naturally along the opposite edge. Doubling back against the axis of the upright capsule gives this membraneous coat, or spermoderm the power to project the seed.

Placing some of the seeds under a lens and puncturing the coat with a needle the rupture was found to occur at other parts than the margin, or at any point the coat might be pricked. In this instance the envelope not having a "back-stop" was often thrown farther than the seed.

When in the capsule the position of the seeds is such as to throw them not only outward but slightly upward. They are cast farther than if projected horizontally. Some seeds were found as far as three feet from the capsule from which they were thrown.

SEPTEMBER 6.

Dr. GEO. H. HORN in the chair.

Fifteen persons present.

SEPTEMBER 13.

Mr. USELMA C. SMITH in the chair.

Thirty persons present.

On the Foramen magnum of the Common Porpoise, and on a Human Lower Jaw of unusual size.—Dr. HARRISON ALLEN invited attention to two skulls of the common porpoise (*Tursiop tursio*) and demonstrated that the foramen magnum in both specimens received no portion of the basi-occipital bone. The exoccipital bones meet in the median line and the posterior border of the basi-occipital bone lies fully one-half an inch in advance of the foramen. The arrangement of parts thus proved to be an exception to the general statement admitted by leading authorities, namely, that the Mammalia are characterized by the lower border of the foramen magnum being formed by the basi-occipital element, and by the occipital condyle not being composed entirely by the exoccipital.

Dr. Allen also invited attention to a human lower jaw of unusual size from the Sandwich Islands. As compared with the lower jaw of an English skull the following measurements will prove of interest.

	Sandwich Islands. INCHES.	England. INCHES.
Height of ascending ramus	3½	2½
Width of ascending ramus	1 6/10	1½
Length of horizontal ramus	3	2 7/12
Goniosymphysal length	4¼	3 8/10
Width of horizontal ramus at first bicuspid	1 6/10	1 4/10
Width of horizontal ramus opposite last molar	1 5/12	1
Symphysal height	1½	1½
Coronoid height	½	½
Condyloid height	½	½
Intergonial width	3½	3½

It will be thus seen that the greatest contrasts in size between an average bone and the one exhibited are to be found in the rami, and the least contrasts, and in most features none at all, in the proportions of the processes and in the width between the angles.

SEPTEMBER 20.

Mr. CHARLES MORRIS in the chair.

Thirty-six persons present.

A paper entitled "A Revision of the North American Creodonta with notes of some Genera which have been referred to that Group," by W. B. Scott, was presented for publication.

SEPTEMBER 27.

Mr. CHAS. P. PEROT in the chair.

Two hundred and two persons present.

Greenland Explorations.—MR. R. E. PEARY, U. S. N., made an informal and preliminary report on his exploration of Greenland during the last twelve months. He announced that he had been able to carry out almost to the letter the plan submitted to the Academy, the merits of which this society, whose practical interest made fruition possible, was the first to recognize. He had traced the northern limit of the interior ice-cap of Greenland and settled the northern extension of the main land-mass. He had completed the surveys of Davis Strait and Inglefield Gulf and he had availed himself of unique opportunities of studying the Arctic Highlanders, a tribe of about two hundred and thirty souls separated from the rest of humanity by the sea and by impassible glaciers, but whose acute ability to obtain their two great necessities: something to eat and something to wear, is not excelled in the world.

Mr. Peary then returned to the Academy the flag presented to him at the setting out of his expedition. It is the only flag which has been carried across the northern boundary of Greenland, or has floated over the east coast above the 77th parallel.

PROF. HEILPRIN read the preliminary report of the Relief Expedition, which will be published in detail at a later date.

The following were elected members:—J. Liberty Tadd, George S. Wolf and N. V. Ball, M. D.

The following was ordered to be printed:—

A REVISION OF THE NORTH AMERICAN CREODONTA WITH NOTES ON SOME GENERA WHICH HAVE BEEN REFERRED TO THAT GROUP.

BY W. B. SCOTT.

The Creodonta form an extremely heterogeneous group, very difficult to define and still more difficult to classify and subdivide. This difficulty arises partly from the imperfection of the available material, but more especially from the lack of diagnostic characters which are common to all the members of the order and from the minute steps of gradation by which they shade into other groups of allied unguiculates and even ungulates. Creodonta were among the earliest fossil mammals which were accurately studied and they were then referred to the carnivores. Laurillard, Pomel and others, however, regarded them as marsupials, and Aymard and Gaudry following this example, have called them Sous-didelphes. In 1875 Cope proposed the name of Creodonta for the group which he regarded as a suborder of the Insectivora, but in 1877 he named this comprehensive order the Bunotheria, referring to it as suborders, the Creodonta, Mesodonta, Insectivora, Tillodonta and Tæniodonta. The creodont division has not found universal acceptance, Filhol regarding them as Carnivora, Wortman as Insectivora and Lydekker as a suborder of the Carnivora. Nevertheless, they cannot be included among either the insectivores or the carnivores without uniting these groups, and it is therefore most convenient to regard them as an order.

The number of genera which should be referred to the Creodonta, the families into which they should be grouped, and their mutual relationships are matters of great obscurity and difficulty, and opinion on the subject has been both conflicting and fluctuating. The reason for this lies largely in the imperfect condition of the available material, the few genera, whose structure is at all completely understood, being for the most part members of highly differentiated side-lines, which have but little importance in estimating the character of the group as a whole. More especially is this true of the Puerco genera, which are known almost exclusively from teeth, together with a few scattered bones, and as the trigonodont (tritubercular) plan of molar tooth is so universal in that formation, the discrimina-

tion of genera, families and even orders from teeth alone is excessively difficult. It may well be the case that several genera which are now referred to the creodonts, really belong to very different orders. *Pantolestes*, for example, was regarded as a creodont until the discovery of the foot-structure showed it to be an artiodactyl. For an opportunity to study the Puerco creodonts, I am indebted to Professor Cope, who, with his accustomed liberality, has placed his unique collection at my disposal. I would also express my thanks to Professor Osborn who, by kindly sending me the advance-sheets of his paper on the Wasatch fauna, has enabled me to incorporate his very interesting observations upon certain genera of that formation.

It would be quite superfluous to recapitulate here all the various schemes of classification which have been proposed for the creodonts, and I shall therefore mention only those presented by Cope and Schlosser. Originally Cope[1] excluded *Mesonyx* and *Hyænodon* from the group and recognized but three families; the *Ambloctonidæ*, with *Ambloctonus* and "perhaps *Palæonictis;*" the *Oxyænidæ*, with *Oxyæna, Stypolophus, Pterodon*, and perhaps *Patriofelis;* the *Arctocyonidæ* with *Arctocyon* and probably *Miacis* and *Didymictis*. In 1884, Cope proposed a new plan of division between the Creodonta and Insectivora, assigning to the former the genera with tritubercular molars and dividing the group, thus greatly enlarged, into eight families; *Mesonychidæ* (including *Ambloctonus*) *Hyænodontidæ, Chrysochloridida, Leptictidæ* (or *Centetidæ*), *Mythomyidæ* (or *Potamogalidæ*), *Talpidæ, Oxyænidæ* (including *Palæonictis*) and *Miacidæ*. In his great work on the Tertiary Vertebrata (1885) the same author removes the existing families of insectivores and the genus *Hyænodon* from the creodonts, but retains provisionally the *Leptictidæ*, from which the *Arctocyonidæ* are removed, and places *Palæonictis* in the *Ambloctonidæ*. Schlosser[2] places the *Centetidæ, Talpidæ, Chrysochloridida* and *Potamogalidæ*, together with the extinct genera, *Leptictis, Ictops, Mesodectes* and *Diacodon* among the Insectivora, refers the *Miacidæ* to the Carnivora and divides the Creodonta into five families: (1) *Arctocyonidæ* with *Arctocyon, Hyodectes, Heteroborus* and *Mioclænus*. (2) *Proviverridæ* with *Deltatherium, Triisodon, Didelphodus, Stypolophus, Quercytherium, Proviverra* and *Cynohyænodon*. (3) *Oxyænidæ* with *Pterodon,*

[1] Rep. U. S. Geogr. Surv. W. 100th Mer. Vol. IV, Pt. II, pp. 87ff.
[2] Die Affen, Lemuren, etc , d. Europ. Tert.

Oxyæna, *Protopsalis* and *Hyænodon*. (4) *Amblyctonidæ*, with *Amblyctonus* and *Palæonictis*. (5) *Mesonychidæ*, with *Mesonyx*, *Dissacus*, *Sarcothraustes*, *Patriofelis* and *Thereutherium*. Later in the same work (1889) he modifies this arrangement by removing the *Miacidæ* from the Carnivora and erecting them into a special group, "Creodonta Adaptiva." I regard Schlosser's scheme as, on the whole, a very natural one and have adopted it with some modification.

For the reasons already explained, the following classification of the Creodonta must be regarded as merely tentative, a provisional attempt to arrange the genera by phyla or lines of divergence, which can be but imperfectly expressed by rigid definitions, even if these lines were much more clearly and completely understood than is the case at present. It may seem that I have unduly increased the number of genera, and that many of these are but vaguely defined. But it should be remembered that in the Puerco, and to a somewhat less degree in the Wasatch, the pattern of the teeth is similar throughout many different groups, and minute differences of tooth-structure must be employed when we have reason to believe that they indicate important differences in the general character of the animal. This is illustrated by *Pantolestes*, an artiodactyl, which was regarded, and with good reason, as a creodont. With our present materials a rigid system is impracticable, because it leads to the unnatural association of forms really very different. But at the same time, it must be admitted that such vagueness is most undesirable and may lead us quite astray. Hence, the emphasis laid upon the provisional character of the scheme.

In the following table of families and in the enumeration of the genera under those families, the problematical and doubtful forms are omitted from consideration and will be discussed at the close of the paper. It must not, however, be inferred from this, that all those genera which are enumerated belong unmistakably to the creodonts; merely that they very probably do so.

I. Fourth upper premolar not forming a well-developed sectorial;[1] sectorials present, if at all, in more than one pair.

1. Superior molars tritubercular, not trenchant; cusps erect and acute; inferior molars tuberculo-sectorial, with trigonid moderately elevated above the talon and not forming a shearing blade; pre-

[1] *Oxyæna* and *Palæonictis* form a partial exception to this statement.

molars simple and trenchant, $\underline{p_4}$ with a deuterocone, and $\overline{p^4}$ sometimes with deuteroconid OXYCLÆNIDÆ.

2. Superior molars more or less completely quadritubercular; trigonid of lower molars very little or not at all higher than talon; paraconid much reduced or absent; all cusps low and massive; premolars high and acute ARCTOCYONIDÆ.

3. Superior molars tritubercular, with low, massive cusps, but sometimes having a well-developed hypocone on $\underline{m_2}$; trigonid much higher than talon, but not forming a shearing blade; paraconid reduced; premolars high and acute TRIISODONTIDÆ.

4. Superior molars tritubercular, not trenchant; inferior molars with metaconid rudimentary or absent; talon trenchant, lacking entoconid. Astragalus deeply grooved, except in *Dissacus* MESONYCHIDÆ.

5. Superior molars tritubercular and somewhat trenchant; para- and metacones closely approximated, and with a cutting crest posterior to the latter; inferior molars with elevated trigonid, forming a trenchant blade PROVIVERRIDÆ.

6. Para- and metacones of superior molars connate or indistinguishably fused, protocone reduced or absent; posterior cutting ridge much enlarged; inferior molars with metaconid and talon reduced or absent; the proto- and paraconids enlarged, flattened and forming an efficient sectorial blade HYÆNODONTIDÆ.

7. Superior molars without or with only rudimentary posterior cutting ridge; para- and metacones very high and pointed and well separated; inferior molars with reduced talon, well developed metaconid; proto- and paraconids enlarged, flattened and forming an efficient sectorial blade. Face shortened PALÆONICTIDÆ.

II. Fourth upper premolar and first lower molar forming the single pair of sectorials; superior molars tritubercular, inferior molars, except the first, also tubercular MIACIDÆ.

OXYCLÆNIDÆ, Fam. nov.

Superior molars tritubercular, not trenchant; cusps erect and acute; inferior molars tuberculo-sectorial, with trigonid moderately elevated above the talon, but not forming a shearing blade; premolars simple and trenchant, $\underline{p_4}$ with a deuterocone and $\overline{p^4}$ sometimes with deuteroconid.

The genera associated to form this family are known almost entirely from the dentition, and their relationship with one another,

even their ordinal position, is very obscure, the teeth being of that generalized and primitive character to which all mammalian types of dentition converge, as we trace them back in time.

OXYCLÆNUS[1] Cope.

Syn. *Mioclænus* Cope,[2] in part.

Only upper dentition known. The anterior premolars form simple, compressed and trenchant cones; on $\underline{P_4}$ there is also a well developed deuterocone. The molars are simply tritubercular, with small, erect and acute cusps. $\underline{M_2}$ is the largest of the series, especially in the transverse direction. The para- and metacones arise close to the outer side of the crown, the latter somewhat nearer to the median line. The protocone is the largest of the elements. There is no distinct hypocone, merely a thickening of the cingulum at that point, which is most marked in $\underline{m_2}$. Minute but very distinct proto- and metaconules are present. $\underline{M_3}$ is very much reduced in size and more oval than triangular in shape, but preserves all the cusps.

One species: *O.* (*Mioclænus*) *cuspidatus* Cope. Puerco.

CHRIACUS[3] Cope.

Syn. *Pelycodus* Cope, in part.

The dentition of this genus is very much like that of the primitive lemuroids, to a genus of which some of the species were originally referred. The character of the symphysis, the spacing of the inferior premolars and the presence of the paraconid, being the only important differences. The upper premolars have compressed and acute protocones and on $\underline{P_3}$ and $_4$ are well developed deuterocones. The upper molars are triangular in shape and much extended transversely; $\underline{m_1}$ has a small hypocone and $\underline{m_2}$ a hypocone and an additional cusp in front of the protocone, which in accordance with Osborn's system of nomenclature, we may call the protostyle; $\underline{m_3}$ is the smallest of the series and has neither hypocone nor protostyle. The anterior lower premolars are simple and spaced apart, but $\underline{P_4}$ has a deuteroconid and heel. In the molars the trigonid is much higher than the talon and the paraconid is reduced; the talon also has three cusps, of which the hypoconulid on $\overline{m^3}$ is in some species enlarged and carried on a distinct fang.

---

[1] Proc. Amer. Phil. Soc., 1883, p. 312.

[2] Trans. Am. Phil. Soc., Vol XVI, Pt. II, p. 320.

[3] Proc. Am. Phil. Soc., 1883, p. 313.

Two species certainly belong to this genus, *C.* (*Pelycodus*) *pelvidens* Cope and *C. truncatus* Cope, both from the Puerco. In addition we may provisionally refer to it three other species, of which the upper dentition is unknown, but whose lower teeth agree closely with those of the typical species; these are: *C.* (*Deltatherium*) *Baldwini* Cope, and *C. stenops* Cope, from the Puerco, and *C.* (*Pelycodus*) *angulatus* Cope, from the Wasatch.

PROTOCHRIACUS, gen. nov.

Syn. *Chriacus* Cope, in part.

This genus is closely allied to *Chriacus*, but differs from it in a number of details. $\overline{P^3}$ has no distinct deuterocone; the upper molars are less extended transversely, the hypocone is smaller and the protostyle absent. In the lower molars the trigonid and talon are of nearly equal height. Two species: *P.* (*Chriacus*) *priscus* Cope, and *P.* (*Chriacus*) *simplex* Cope. Puerco.

EPICHRIACUS, gen. nov.

Syn. *Chriacus* Cope, in part.

In this genus the upper molars resemble those of *Chriacus* but the last lower premolar has all the elements of a molar, though not fully developed. The trigonid rises considerably above the talon. The third molar in both jaws is very much reduced. The mandible is long and slender. The humerus has a thin, broad and low trochlea with large epicondylar foramen and very prominent supinator ridge. The ulna has a long olecranon and the sigmoid notch is very oblique to the line of the shaft. The astragalus is very peculiar; the trochlea has a remarkably limited antero-posterior extent and is nearly flat transversely, but very oblique, high on the external and very low on the mesial side, where there is a depression for the internal malleolus of the tibia. The ectal calcaneal facet is very large and widely separated from the sustentacular facet, which is very narrow; the neck is very slender and directed obliquely distally and inward.

One species: *E.* (*Chriacus*) *schlosserianus* Cope: Puerco.

PENTACODON, gen. nov.

Syn. *Chriacus* Cope, in part.

Upper teeth unknown. Anterior lower premolars very small and simple in construction, p_4 is large, with large heel and very distinct deuteroconid. The molars increase in size from the first to the

third, which is very large proportionately; its talon is remarkable for the entire absence of the entoconid; the hypoconid and hypoconulid form very acute cusps upon the external and posterior borders of the talon respectively, the valley of which thus opens inward without obstruction.

One species: *C.* (*Chriacus*) *inversus* Cope: Puerco.

LOXOLOPHUS[1] Cope.

Syn. *Chriacus* Cope, in part.

The superior molars are tritubercular with very minute hypocone, and are remarkable for their antero-posterior as compared with their transverse extent. The lower molars have a high trigonid with all three cusps well developed and basin-shaped talon with elevated hypoconid.

One species: *L. hyattianus* Cope (Syn. *Chriacus hyattianus*[2] Cope, *Loxolophus adapinus*[3] Cope). Puerco.

TRICENTES[4] Cope.

Syn. *Mioclænus* Cope, in part.

This genus is very closely allied to *Protochriacus*, but differs in the absence of $\underline{P_1}$. The premolars are compressed, acute, very high and simple, except $\underline{P_4}$ which has a small deuterocone. $\underline{M_1}$ and $_2$ have a nearly quadrate shape, produced by the well developed hypocone and are surrounded by a stout cingulum. $\underline{M_3}$ is the smallest of the series, the hypocone is absent and the metacone reduced. The canine is large and separated from $\underline{P_2}$ by a considerable diastema. Inferior dentition unknown. The face is very short and the anterior edge of the orbit is over the space between $\underline{P_4}$ and $\underline{m_1}$. The forehead is flat, the supraciliary ridges short and converging rapidly to form the sagittal crest.

Two species may certainly be referred to this genus: *T.* (*Mioclænus*) *bucculentus* Cope and *T. crassicollidens* Cope, Puerco. A third species is doubtful, viz., ? *T.* (*Mioclænus*) *subtrigonus* Cope, in which the number of upper premolars is not known, but the tooth structure agrees closely with *Tricentes*. Puerco.

---

[1] Amer. Naturalist, 1885, p. 386.
[2] Loc. cit., p. 385, Trans. Am. Phil. Soc., Vol. XVI, Pt. II, p. 304.
[3] Am. Nat. 1885, p. 386.
[4] Proc. Am. Phil. Soc., 1883, p. 316.
[5] Trans. Am. Phil. Soc., loc. cit., p. 304.

ELLIPSODON, gen. nov.

Syn. *Tricentes* Cope, in part.

The systematic position of this form is entirely obscure; it agrees with *Tricentes* in having but three upper premolars, but differs entirely in the construction of the molars. The premolars are relatively broad and massive, almost as in *Mioclænus;* $\underline{p_4}$ is especially broad and has a very large deuterocone. The molars are oval in shape and have no hypocone; $\underline{m_2}$ is the largest of the series and $\underline{m_3}$ very greatly reduced and forms a mere oval-shaped rudiment, without recognizable elements. Inferior dentition unknown.

One species: *E.* (*Tricentes*) *inæquidens* Cope. Puerco.

Though technically *Chriacus* and its allies, so far as their structure is at present known, belong among the creodonts, their general aspect is very similar to that of the Eocene Primates and it is difficult to resist the suspicion that they will eventually prove to be primitive ancestral forms of that group.

ARCTOCYONIDÆ Cope.

Superior molars more or less completely quadritubercular; trigonid of lower molars very little or not at all higher than talon; paraconid much reduced or absent; all cusps of molars low and massive, premolars high and acute.

CLÆNODON, gen. nov.

Syn. *Mioclænus* Cope, in part.

In the present state of knowledge it is very difficult to justify the separation of this form from the European genus *Arctocyon* and yet the identification of genera from different continents upon insufficient materials is quite as apt to lead to erroneous conclusions in questions of geological correlation and zoological distribution, as the opposite course is to cause confusion from a systematic point of view. In view of this choice of evils, I have provisionally suggested a new name. A not unimportant difference from *Arctocyon* is the less completely quadritubercular character of the upper molars. From *Hyodectes* it differs in the greater simplicity of the molars and lack of secondary tubercles, as well as in the less extreme reduction of m^3, while it may be distinguished from *Heteroborus* by the presence of p^1, which is absent in that genus. In *Clænodon* the upper molars are subquadrate in outline, with fairly well developed hypocone. M_2 is the largest of the series, $\underline{m_3}$ the smallest.

The anterior lower premolars are small and feeble; $\overline{p^1}$ is implanted by a single fang and is separated by a diastema from $\overline{p^2}$, which has two roots. $\underline{P_4}$ is much the largest of the series and consists of a high, acute and trenchant cone with a strong cingulum, which forms minute anterior and posterior basal cusps. The lower molars are longer and narrower than the upper; the talon is larger than the trigonid and the paraconid is much reduced or absent. $\underline{M_3}$ has a distinct hypoconulid. The mandible is long and stout, with regularly curved inferior border and large, deeply marked masseteric fossa. The zygapophyses of the lumbar vertebræ display the involuted and interlocking shape characteristic of the creodonts. The manus is pentadactyl, plantigrade, and remarkable for the very slight degree of interlocking of the metacarpals. The fibula is very stout and forms an exceedingly massive external malleolus. The astragalus is much like that of *Arctocyon*, but has a longer, narrower and somewhat flatter trochlea and, as in that genus, is perforated by a foramen.

Two species are clearly referable to *Clænodon*: *C.* (*Mioclænus*) *ferox* Cope, and *C.* (*Mioclænus*) *corrugatus* Cope. A third species, *C.* (*Mioclænus*) *protogonioides* Cope, cannot be technically separated from it, but the general appearance of the teeth is so different from those of the typical species as to justify the suspicion that more complete material will cause its removal to another group. In particular, its resemblance to ? *Tricentes subtrigonus* has been noted by Cope.

TETRACLÆNODON, gen. nov.

Syn. *Mioclænus* Cope, in part.

Superior dentition unknown; the inferior molars are like those of *Clænodon*, but the premolars are very different. The anterior ones are relatively larger and more massive; $\overline{p^3}$ is a stout, compressed cone and has a minute anterior basal cusp (paraconid) and a small heel, which forms two basin-like depressions, divided by a median ridge. $\overline{P^4}$ has all the elements of a molar, with a massive protoconid and small para- and deuteroconids; the heel is low and composed of two cusps (meta- and tetartoconids). The s are co ucted as in *Clænodon*, but are less rugose than in ıer of t ubt species of that genus. The hume y small tuberosities and wide, shallow ridge is very prominent and runs fa than in *Arctocyon*. The troch

than in that genus, and the supinator ridge less prominent; the entepicondyle is very large and is perforated. The distal end of the radius is narrow and flattened, and the facets for the scaphoid and lunar are separately marked, a very unusual feature among creodonts. The ilium is strongly trihedral and very little expanded; the inferior surface is broad and the spine prominent.

One species: *T.* (*Mioclænus*) *floverianus* Cope. Puerco.

ANACODON[1] Cope.

This genus was founded upon the inferior molars and referred to the Condylarthra. Osborn[2], however, who has obtained more extensive material, regards it as a creodont and member of the present family. According to him, the molar formula is $P\frac{1}{3}$ $M.\frac{3}{3}$ and the dentition presents the following pecularities: "(1) The enlargement of the second molar in both jaws, the smaller size of the first and third and the very marked reduction of the entire premolar series.....(2) The degenerate condition of the cusps of the molars and the formation of innumerable secondary tubercles or crenations. (3) The probable presence of a wide diastema." $\underline{P_4}$ has trito- and deuterocones and the tetartocone is represented by a low ridge, distinct from the cingulum, and thus has the constitution of a molar. The upper molars are of a broad oval shape, with very low main cusps, small hypocone and very much wrinkled and tuberculate surface. $\overline{P^3 \text{ and } 4}$ are small and have only a low heel in addition to the protoconid. $\overline{M^3}$ has an enlarged hypoconulid.

One species: *A. ursidens* Cope: Wasatch.

TRIISODONTIDÆ, Fam. nov.

Superior molars tritubercular with low, massive cusps, sometimes having a well developed hypocone on $\underline{m_2}$; trigonid of lower molars much higher than talon, but not forming a shearing blade, paraconid reduced; premolars high and acute.

TRIISODON[1] Cope.

This genus has many suggestions of affinity with the *Mesonychidæ*, from which it differs in the less reduced and simplified dentition. The upper teeth and the anterior lower premolars are not known. The canine is large and of oval section, without cutting edges. $\overline{P^2}$ is small and $\overline{p^4}$ very large, with very high, acute and

[1] Proc. Am. Phil. Soc., 1881, p. 181.
[2] Bull. Am. Mus. Nat. Hist., Vol. IV, pp. 115–118.

trenchant protoconid and a talon of two trenchant cusps, of which the external is much the higher and more acute. Seen from the outer side, this tooth closely resembles the corresponding one of *Dissacus*, differing only in the presence of the tetartoconid. In the molars the trigonid rises considerably above the talon and is composed of a high, sharp and massive protoconid, of a small, low metaconid, and a still smaller and lower paraconid; the two latter cusps are on the same antero-posterior line and, in $\overline{m^2}$ at least, are not visible from the external side. The talon consists of a high and sharp hypoconid with trenchant anterior edge and internally three very much smaller cusps, representing the hypoconulid, entoconid and a tubercle in front of the latter to which no name has been given. This crenulate inner border of the talon is highly characteristic of the genus.

Three species: *T. quivirensis* Cope, *T. biculminatus* Cope and *T.* (*Mioclænus*) *heilprinianus* Cope. In his last publication[2] Cope refers the *T. heilprinianus* to a subgenus (*Goniacodon*) of *Mioclænus*, but the talon of the only known tooth agrees best with that of *Triïsodon*.

GONIACODON[3] Cope.

Syn *Mioclænus* Cope, in part; *Triïsodon* Cope, in part.

Though established only as a subgenus of *Mioclænus*, this group of species should be raised to full generic rank; it is closely allied on the one hand to *Triïsodon* and on the other to *Sarcothraustes*, the distinction between the three being frequently a matter of much difficulty. The species are of moderate size, smaller on the average than those of either of the allied genera. The anterior upper premolars are small and simple. $\underline{P^3}$ is implanted by three fangs (at least in *G. levisanus*) but has no distinct deuterocone. $\underline{P^4}$ has a very high, acute protocone and well developed deuterocone. The upper molars are triangular in shape with low, conical cusps and $\underline{m^1}$ has a fairly well developed hypocone. $\overline{P^4}$ has a small talon, divided into minute outer and inner cusps. The lower molars are the characteristic feature of the genus; the trigonid is moderately elevated above the talon; the proto- and metaconids [illegible] the same size and very closely approximated, formi[illegible]

[1] Amer. Naturalist, 1881, p. 667.
[2] Trans. Am. Phil. Soc., Vol. xvi, Pt. II, p. 321.
[3] Loc. cit.

which is cleft but a short distance below the apex; the paraconid is very small, depressed and submedian in position, *i. e.*, standing in front of the space between the proto- and metaconids. The talon is basin-shaped and consists of hypo- and entoconids which may be of nearly the same size (*G. rusticus*) or the former may be much the larger (*G. levisanus*). A minute hypoconulid is also present. $\overline{M}^3$ is much reduced.

Three species: *G.* (*Triïsodon, Mioclænus*) *levisanus* Cope, *G.* (*Mioclænus*) *gaudryanus* Cope, and G. (*Triïsodon, Mioclænus*) *rusticus* Cope. Puerco.

MICROCLÆNODON, gen. nov.

Syn. *Mioclænus* Cope, in part.

Known only from lower molars, which are much like those of *Goniacodon*, especially in the constitution of the trigonid, but the talon is very different and agrees with that of *Deltatherium* and *Pentacodon* in the absence of the entoconid and large size of the hypoconulid, especially in $\overline{m^3}$; the valley is thus widely open on the inner side.

One species: *M.* (*Triïsodon, Mioclænus*) *assurgens* Cope. Puerco.

SARCOTHRAUSTES[1] Cope.

Syn. *Mioclænus* Cope, in part.

The largest Puerco Creodonts are to be found among the species of this genus. The superior molars, so far as they are known, and the lower premolars agree closely with those of *Goniacodon*, the only differences being their larger size, more massive cusps, thicker and more prominent cingulum, especially at the antero-external angle of the crown. $\underline{M}_3$ is oval in shape and reduced in size, having lost the metacone. The anterior lower premolars are remarkable for their small size and simple construction, but p_4 is very much larger and higher and has a large talon, divided into inner and outer cusps. The lower molars differ from those of *Goniacodon* in the composition of the trigonid; the protoconid is much the largest element, the para- and metaconids are greatly reduced and placed on the same fore and aft line, as in *Triïsodon*, but the talon is very different, consisting of hypo- and entoconids and small hypoconulid, which may or may not be much enlarged on m_3, the size of which tooth is very variable in the different species. The skull has a very small cranial cavity and a very high occipital crest, which is

[1] Proc. Am. Phil. Soc., 1881, p. 193.

arched from side to side and continued forward into an extremely prominent sagittal crest. The zygomatic arches are heavy and project strongly from the skull; the glenoid cavity is deeply concave, with prominent pre- and post-glenoid crests. The mandible varies much in size and proportions among the different species, being in some long and slender and in others very massive, but in all the ascending ramus is of remarkable antero-posterior extent, the distance from the condyle to $\overline{m^3}$ exceeding the length of the molar premolar series. The condyle is placed low down and there is a short hooked angular process. The masseteric fossa is large but shallow, especially so in the larger species.

In his latest paper[1] on the Puerco fauna Cope classifies *Sarcothraustes* as a subgenus of *Mioclænus*, a view which is obviously untenable, as the affinities of the genus are much more nearly with the *Mesonychidæ*, in which family Schlosser has included it.

There are five well marked species of *Sarcothraustes*, all of which are from the Puerco beds: *S. antiquus* Cope, *S. coryphæus* Cope, *S. bathygnathus* Cope and *S.* (*Conoryctes*, *Mioclænus*) *crassicuspis* Cope.

MESONYCHIDÆ Cope.

Superior molars tritubercular, not trenchant; inferior molars with metaconid rudimentary or absent; talon trenchant, lacking entoconid. Astragalus deeply grooved, except in *Dissacus*, and articulating with the cuboid.

The long continued existence of this family, throughout the entire Eocene and into the White River Miocene, brought with it numbers of important changes in dental and skeletal structure, so that characters diagnostic of the entire family are difficult to find, and yet the close relationship and succession of the various genera are so clear and obvious that it is impracticable to place them in more than one family.

DISSACUS[2] Cope.

This, the oldest member of the series, is in many respects closely similar to *Goniacodon* and *Triisodon*, but with important differences. The dental formula is unreduced, but the upper premolars have already attained a considerable degree of complication. $\underline{P_3}$ is much elongated antero-posteriorly and has a small deuteroco ; $\underline{P_4}$ is completely molariform, having a distinct tritocone in tion to the

[1] Trans. Am. Phil. Soc., Vol. xvi, Pt. II. p.
[2] Amer. Naturalist, 1881, p. 1019.

large deuterocone. The upper molars are very simple and consist of a large crescentic protocone, and low, compressed para- and metacones, the latter somewhat the smaller of the two. In the lower jaw $\overline{p^1}$ is very small and simple, implanted by one fang. $\overline{P^{2, 3 \text{ and } 4}}$ are all alike, except in size, which increases posteriorly; these teeth consist of a high, acute, trenchant and recurved protoconid, and a low cutting heel, but with no paraconid, except for a rudimentary one on $\overline{p^4}$. In the lower molars the protoconid is greatly enlarged, compressed, acute and with cutting edges; the metaconid has almost completely fused with the protoconid, from which it is separated only by a very shallow groove; the paraconid is much reduced and forms a low anterior basal cusp; the talon consists of the hypoconid only, which has a trenchant upper margin. The mandible is slender, with long symphysis which reaches to $\overline{p^3}$. The posterior thoracic and lumbar vertebræ have the characteristic creodont feature of involuted zygapophyses. In the humerus the entepicondyle is less prominent than is usual among creodonts, but retains the foramen; the trochlea is low, but distinctly convex. The ulna has a long olecranon. The head of the radius is transversely oval and displays three humeral surfaces. The astragalus is very slightly grooved, and the trochlear surface extends to the middle of the neck; distally there is a distinct facet for the cuboid, separated from the navicular surface by an angle; the body of the bone is pierced by a foramen. The calcaneum has a long tuber calcis and rather small sustentaculum. The proximal end of the cuboid exhibits separate facets for the calcaneum and astragalus. The feet were plantigrade and pentadactyl.

Three species have been referred to this genus: *D. navajovius* Cope, and *D. carnifex* Cope are from the Puerco and *D. leptognathus* Osborn is from the Wasatch, but being known from a single molar only, is provisionally placed in this genus.

PACHYÆNA[1] Cope.

Syn. *Mesonyx*[2] Cope, in part.

$I\frac{3}{3}$, $C\frac{1}{1}$, $P\frac{4}{4}$, $M\frac{3}{3}$. The incisors are small, the canines very robust. $\underline{P_1}$ is small, single-rooted and separated by a short diastema from

[1] Rep. Vert. Foss. New Mexico, U. S. Geog. Surv. W. 100th Mer., 1874, p. 13.

[2] *Mesonyx ossifragus*, Tert. Vert. p. 362.

P_2 which is somewhat larger and has a tritocone; P_3 is similar but larger and P_4 is completely molariform, but the tritocone is smaller than the protocone. The molars have very massive cusps and exhibit a reduction of the metacone in favor of the paracone; m_3 is the smallest of the series and has lost the metacone entirely. The lower incisors are reduced to two small teeth in each ramus. $\overline{P^1}$ is small and single rooted, separated from the canine by a short space; $\overline{p^2 \text{ and } 3}$ are larger and have a well developed cutting talon, while $\overline{p^4}$ is the largest of the series and rendered completely molariform by the addition of a paraconid. The molars differ from those of *Dissacus* in the entire absence of the metaconid, or perhaps it would be more correct to say that it has become completely fused with the protoconid. The skull has a very long cranium and short face, the zygomatic arches are extremely long, massive and widely expanded. The mandible has a slender horizontal ramus and extremely broad ascending ramus, ending in a bluntly rounded and slightly everted coronoid; the angle is truncate and not continued into a distinct process; the symphysis is unusually long. The limb-bones of this genus, as described by Cope, show a remarkable disproportion between the length of the fore and hind legs. The humerus is very short and stout, with a very prominent deltoid crest, which extends nearly the whole length of the shaft; there is no distinct intertrochlear prominence; the entepicondyle is very prominent and pierced by a foramen. The ulna is long in proportion to the humerus and has a strikingly long olecranon. The radius has a transversely oval head and massive distal end. The femur is long and stout, the tibia long and rather slender. The astragalus is well grooved and has a large cuboidal facet which is nearly half as wide as that for the navicular, a character unknown among creodonts, except in this family. The metapodials are short, the phalanges depressed, the unguals flattened and almost hoof-like.

The species of this group were the largest of the Eocene flesh-eaters and must have presented an exceedingly curious appearance when in life from the disproportion between the great head, exceeding that of the largest grizzly bears in size, and the small weak feet, as well as that between the length of the fore and hind limbs.

Two species: *P.* (*Mesonyx*) *ossifraga* Cope and *P. gigantea* Osborn. Wasatch.

MESONYX[1] Cope.

Syn. *Synoplotherium*[2] Cope, *Dromocyon*[3] Marsh.

I have elsewhere[4] given a very full acount of the osteology of this genus, and shall therefore devote but a small space to it here, emphasizing especially the points in which it differs from *Pachyœna*. The dental formula is $I\frac{3}{3}$ $C\frac{1}{1}$ $P\frac{4}{4}$ $M\frac{3}{3}$. The upper molars differ from those of *Pachyœna* in the equal size of the para- and metacones, and $\underline{p}^4$ is even more completely molariform, all three cusps being of nearly equal size. In the lower jaw the premolars, except $\overline{p}^1$, have assumed the molar pattern by the addition of the paraconid and trenchant talon. The molars differ from those of *Pachyœna* in the reduction of the paraconid and enlargement of the talon, and in the simplification of $\overline{m}^3$, in which the paraconid is rudimentary or absent and the talon very small. The humerus lacks the entepicondylar foramen and has a remarkably well developed trochlea, which is high, thick and with very large intertrochlear prominence, so as to resemble the corresponding part of a perissodactyl. The ilium is like that of the bears and much more expanded than in any other known creodont. The hind limb does not much exceed the fore limb in length. The feet are digitigrade and tetradactyl, the metapodials symmetrically arranged as in the hyæna and the metacarpals very completely interlocked. In this genus the size of the head and length of trunk are very great, as compared with the length of the limbs and feet.

Three species of the genus have been described: *M. obtusidens* Cope (*Dromocyon vorax* Marsh), *M.* (*Synoplotherium*) *lanius* Cope, which are from the Bridger, and *M. uintensis* Scott, from the Uinta, a much larger species. To these may be provisionally added a fourth which was obtained by the Princeton expedition of 1890 in the White River bad lands of South Dakota. The specimen consists of a fore leg, unfortunately not associated with teeth and therefore its reference to this genus cannot be considered final, though there can be little doubt that it belongs to a member of the family. The species may be named and described as follows:

? Mesonyx dakotensis, sp. nov.

Size greater than that of either of the Bridger species, less than *M. uintensis*. The distal end of the humerus is broader and more flat-

[1] Proc. Am. Phil. Soc., 1872, p, 460.
[2] Loc. cit. p. 483; referred to *Mesonyx*, Tert. Vert. p. 358.
[3] Am. Journ. Sci. and Arts 3d Ser., Vol. XII, 1876, p. 403.
[4] Journ. Acad. Nat. Sci. Phila., Vol. IX, no. 2.

tend than in *M. obtusidens*, the trochlea lower and wider with more rounded and hemispherical intertrochlear ridge; the entepicondyle is more prominent, but has no foramen, and the supinator ridge less so. The ulna and radius do not differ in any important respect, except size, from those of the Bridger species, the greater transverse breadth of the shaft of the ulna and the shorter and broader olecranon. The manus is also constituted very much as in *M. obtusidens*, but the ulnar side of the carpus, and especially the cuneiform, is broader. The metacarpals are even shorter in proportion and mc. V more slender and displaced more to the ulnar side of the unciform. The following measurements exhibit the proportions of the various parts of the fore limb in the two species.

	M. obtsidens.	*M. dakotensis.*	
	M.	M.	
Humerus, width of trochlea,	.027	.039	
Ulna, length,	.207	.208	(approx.)
Ulna, length olecranon,	.048	.035	
Ulna, width, distal end,	.015	.015	
Radius, length,	.160	.167	(approx.)
Radius, width proximal end,	.023	.030	
Radius, width distal end,	.024	.028	
Metacarpal II, width prox. end,	.014	.008	
Metacarpal III, width prox. end,	.011	.015	
Metacarpal IV, length,	.065	.060	
Metacarpal IV, width prox. end,	.010	.012	
Metacarpal V, length,	.050	.051	
Metacarpal V, width prox. end,	.014	.009	

This species, so far as it is at present known, is of no particular morphological importance, but geologically it is of much interest, as adding another to the increasing list of White River genera of ancient type which justify Cope's comparison of that horizon with the Oligocene of Europe.

PROVIVERRIDÆ Schlosser.

Syn. *Leptictidæ* Cope, in part.

Superior molars tritubercular and somewhat trenchant; para- and metacones closely approximated and with a cutting crest posterior to the latter; inferior molars with elevated trigonid, forming a trenchant blade.

DELTATHERIUM[1] Cope.

Syn. *Lipodectes*[2] Cope.

$I\frac{3}{3}$ $C\frac{1}{1}$ $P\frac{3}{3}$ $M\frac{3}{3}$. This genus has already become quite specialized through the loss of one premolar in each jaw and the complication of p^4. P_2, the most anterior premolar, is simple, compressed and with cutting edges. P_3 is more pyramidal in shape and is supported by three fangs, though it has no deuterocone, which is well developed on p_4. The molars are triangular in shape, with only a slightly thickened cingulum representing the hypocone; m_1 is the largest and m_3 the smallest of the series. The para- and metacones are somewhat approximated and are moved mesially from the outer edge of the crown; from the metacone is given off a short, curved, trenchant crest which runs to the postero-external angle of the crown, and at the antero-external angle there is a small parastyle; the conules are rudimentary or absent. In m_3 the metacone is rudimentary and has no posterior crest. The anterior lower premolars are simple, but p_4 has become almost molariform, with well developed trigonid formed by the addition of the para- and deuteroconids, but the heel is rudimentary. The lower molars are very primitive; the trigonid retains all the elements and the meta- and paraconids are on the same fore and aft line, so that there is only a beginning of a shearing blade; the talon has become trenchant through loss of the entoconid. The skull has a very long and narrow cranium, with cerebral fossa of small capacity; the face is short and the orbits placed far forward, much in advance of the very deep post-orbital constriction; the nasals and parietals do not lie in the same plane, the profile of the skull rising somewhat at the forehead; the sagittal crest is very long and high; the occiput is low and broad and the occipital crest strongly developed.

One species: *D. fundaminis* Cope, (Syn. *Lipodectes penetrans* Cope). Puerco.

SINOPA[3] Leidy.

Syn. *Limnocyon*[4] Marsh, in part, *Stypolophus*[5] Cope, *Prototomus*[6] Cope, *Triacodon*[7] Cope.

In view of the imperfect condition of Leidy's type and the meagre description which he gave of it, I have hesitated long in adopting

[1] Amer. Naturalist, 1880, p. 338.
[2] Loc. cit. 1881, p. 1019.
[3] Proc. Acad. Nat. Sci., 1871, p. 115.
[4] Am. Journ. Sci. 3rd Ser., Vol. IV, 1872, p. 126.
[5] Proc. Am. Phil. Soc., 1872, p. 446.
[6] Rept. Vert. Foss. New Mexico, 1874, p. 13.
[7] Proc. Am. Phil. Soc., 1872, p. 460.

his name. There can, however, be no doubt that all of the above names refer to the same generic group, and I have taken the name first proposed, though our knowledge of the structure of these forms is entirely due to Cope, who has described and figured them with great fulness. Cope[1] separates *Stypolophus* from *Sinopa* on the ground that in the latter the last lower molar has a rudimentary talon, but in this group this character is too variable to be of generic significance, though, of course, it often is so in others. The teeth are unreduced in number. The anterior upper premolars are quite simple except that P_3 has a small deuterocone and is implanted by three fangs. P_4 has the composition of the sectorial among the Carnivora, consisting of large proto- and deuterocones with a small tritocone forming a trenchant blade. But for its small size, this tooth would be called a sectorial; there is also a thickening of the cingulum at the antero-external angle of the crown, forming a minute protostyle. The first and second upper molars are alike, except in size, m_2 being the larger; they are much extended transversely, the para- and metacones are closely approximated and a well developed trenchant crest runs from the latter to the postero-external angle of the crown, which is longer and more prominent than in *Deltatherium* and not, as in that genus, continuous with the metacone, but separated from it by a cleft. The shifting of the outer cusps inward from the external margin of the crown, which has already commenced in the Puerco genus, is very marked in *Sinopa*. The conules are rudimentary or absent, but m_1 has a minute and m_2 a very large parastyle. M_3 is much reduced, especially in the antero-posterior direction, having lost the metacone, while the paracone has moved inward nearly to the middle of the crown. The inferior premolars are simple; $\overline{p^1}$ is very small, single-rooted and isolated by a diastema both in front of and behind it; the other premolars are two fanged and form acute compressed cones; $\overline{p^2}$ is without accessory cusps, $\overline{p^3}$ has a small posterior and $\overline{p^4}$ both anterior and posterior basal cusps. $\overline{M^1}$ is conspicuously smaller than the others, but has the same construction; the trigonid is very high, especially the protoconid; the paraconid is more on the same fore and aft line with the protoconid than in *Deltatherium* and the two together form a correspondingly more efficient shearing blade; the talon is much reduced, especially in $\overline{m^3}$, but retains its basin shape, formed by the hypo- and ento-conids; the hypoconulid is lost. In the

[1] Tertiary Vertebrata, p. 289.

skull we observe the long, narrow cranium, which has but small cerebral capacity, with very marked post-orbital constriction, prominent sagittal and occipital crests and long zygomatic arches. The roof of the cranium and that of the face lie in nearly the same plane; the face is short and tapering; the anterior nares are terminal in position and overhung by the tips of the nasals, which project beyond the premaxillaries. The mandible is long and slender, with very broad ascending ramus and high, recurved and blunt coronoid process; the masseteric fossa is very large and deep and the angular process long and prominent.

The neck is of moderate length, the lumbar vertebræ stout, with well developed anapophyses, and the tail long. The astragalus is nearly flat in some species, moderately grooved in others; it has a long neck, with rounded, narrow head, which displays a small facet for the cuboid. The calcaneum has a long and slender *tuber calcis* and a small sustentaculum, and above the distal end is considerably expanded, as in the plantigrade carnivores. The cuboid is very high and narrow; the calcaneal facet is transverse and the astragalar narrow and oblique. The carpus is low and the scaphoid and lunar separate.

Sinopa is very abundantly represented in the Wasatch and Bridger, not less than thirteen species having been described, ranging in size from a weasel to a fox. *S. rapax* Leidy, *S.* (*Limnocyon*) *verus* Marsh and *S.* (*Limnocyon*) *agilis* Marsh, *S.* (*Stypolophus*) *pungens* Cope, *S.* (*Stypolophus*) *insectivorus* Cope, *S.* (*Stypolophus*) *brevicalcaratus* Cope and *S.* (*Triacodon, Stypolophus*) *aculeatus* Cope, are from the Bridger; *S.* (*Prototomus, Stypolophus*) *viverrinus* Cope, *S.* (*Prototomus, Stypolophus*) *secundarius* Cope, *S.* (*Prototomus, Stypolophus*) *multicuspis* Cope, *S.* (*Prototomus, Stypolophus*) *strenuus* Cope and *S.* (*Stypolophus*) *hians* Cope, are from the Wasatch, while *S. whitiæ* Cope (*Stypolophus strenuus* Cope, in part, *Stypolophus whitiæ* Cope), has been found in the Wasatch and Wind River beds. *Sinopa eximia*[1] Leidy probably does not belong to this genus and Schlosser has referred it to the Primates. *Limnocyon riparius*[2] Marsh likewise must be removed from the genus, as in it $\overline{m^3}$ and ^{3} are described as being tubercular.

[1] Cont. to Ext. Vert. Fauna of Western Territories p. 118.
[2] Am. Journ. of Sci. and Arts, 3rd Ser., Vol. IV, p. 203.

PROVIVERRA[1] Rütimeyer.

This genus is very similar to *Sinopa*, differing from it only in the structure of the last upper premolar (P_4) which is as simply constructed as in *Deltatherium* and consists of a triangular, trenchant protocone, a large, conical deuterocone, with no trace of either tritocone or protostyle. To this European genus may be provisionally referred a species from the Bridger beds, ? *P. americanus* sp. nov. (Syn. *Sinopa rapax* Osborn, Scott and Speir[2] *non* Leidy) which differs from its European congener merely in size, so far as the very imperfect specimen will admit of comparison. The specimen consists only of a jaw fragment containing p_3 and $_4$ which may possibly represent a Bridger species of *Didelphodus*, but the general *facies* of the tooth agrees better with *Proviverra*. The dimensions of P_4 are: ant.-post. diameter, 7 mm., transverse, 7 mm.

DIDELPHODUS[3] Cope.

Syn. *Deltatherium* Cope, in part.

This genus resembles *Proviverra* in the structure of the teeth, especially of P_4, but appears to have lost P_1, giving the formula $I\frac{3}{3}$ $C\frac{1}{1}$ $P'\frac{3}{4}$ $M\frac{3}{3}$. From *Sinopa* it differs in the simple canine-like shape of P_2, the presence of a deuterocone on P_3 and of a corresponding element on $\bar{p}^4$, and the less reduction of m_3. An important difference from both genera consists in the much less pronounced development of the posterior cutting crest on the upper molars. The premolars are all notably high and acute.

One species: *D.* (*Deltatherium*) *absarokæ* Cope. Wasatch.

PALÆONICTIDÆ.

Syn. *Ambloctonidæ* Cope.

Superior molars without or with only rudimentary posterior cutting ridge; para- and metacones very high and pointed and well separated; inferior molars with reduced talon and well developed metaconid; proto- and paraconids enlarged, flattened and forming an efficient sectorial blade. Face much shortened.

PALÆONICTIS[4] de Blainville.

The discovery of this genus by Wortman in the Wasatch be in 1891 is one of very great interest and importance, both geol cal

[1] Eocäne Säugethiere, p. 80.
[2] Pal. Rept. of the Princeton Scientific Expedition of 1877, p. 18.
[3] Amer. Naturalist, 1882, p. 463.
[4] Ostéographie, Viverra, p. 76.

and morphologically. The advance sheets of Osborn and Wortman's paper enable me to give a brief account of it here. The dental formula is $I\frac{3}{3}$ $C\frac{1}{1}$ $P\frac{4}{4}$ $M\frac{2}{2}$. The superior premolars increase regularly in size from before backward. $\underline{P_1}$ is small, simple and one-rooted; $\underline{p_2}$ is also small and has an incipient deuterocone, represented by an elevated and crenulate internal cingulum; on $\underline{p_3 \text{ and } 4}$ the deuterocone is distinct and supported on a separate fang; $\overline{p^4}$ has three external cusps, a high protocone, a smaller tritocone which forms a trenchant heel, and a small protostyle; the tooth thus has all the elements of the feline sectorial. $\underline{M_1}$ is large and strictly trigonodont; the cusps are all very high and acute, the para- and metacones show no tendency to coalesce and there is no posterior trenchant crest given off from the metacone. $\underline{M_2}$ is very small, a mere oval rudiment, with no distinguishable elements. The anterior lower premolars all have a compressed, pointed and trenchant protoconid and a small posterior basal cusp, and $\overline{p^4}$ has an anterior cusp in addition. In the molars the proto- and paraconids are flattened, brought into nearly the same antero-posterior line and form an efficient shearing blade, but retaining a well developed metaconid; the talon is small and basin-shaped and on $\overline{m^2}$ very much reduced.

The cranium is long and the face much shortened; the orbits are large and situated far forward; the anterior nares are very large and the muzzle abruptly truncated. The mandible has a short, deep and massive horizontal ramus and a very broad ascending ramus, which terminates in a blunt coronoid; the chin is abruptly rounded and the symphysis short. The physiognomy of this skull is strikingly feline in character.

One American species: *P. occidentalis* Osborn: Wasatch.

AMBLOCTONUS[1] Cope.

The only known specimens of this genus are so much mutilated that an accurate account of it cannot be given. According to Osborn[2] the dental formula is $P\frac{4}{4}$ $M\frac{1}{1}$. The external upper incisor is much enlarged and the canines are of great size. $\underline{P_4}$ is triangular in shape, with very large deuterocone, a trenchant tritocone and a small protostyle. $\underline{M_1}$ differs from that of *Palæonictis* in the reduction

[1] Syst. Cat. Vert. Eocene of New Mexico, U. S. Geog. Surv. W. of 100th Mer., 1875, p. 7.

[2] Loc. cit.

of the protocone, the close approximation of the para- and metacones and the elevation at the postero-external angle of the crown, simulating the trenchant ridge of the *Proviverridæ* and *Hyænodontidæ*. This tooth strongly suggests a doubt as to the propriety of referring this genus to the present family, which cannot be decided until more perfect specimens are obtained. $\overline{P^4}$ is very nearly molariform, but does not appear to have a deuteroconid. The composition of $\overline{m^1}$ cannot be determined, while $\overline{m^2}$ appears to have lost the metaconid and the talon is rudimentary or absent.

One species: *A. sinosus* Cope: Wasatch.

PATRIOFELIS[1] Leidy.

Syn. *Limnofelis*[2] Marsh, in part, *Oreocyon*[3] Marsh.

Only the inferior dentition is known; the dental formula appears to be: $I_{\frac{3}{3}}$, $C_{\frac{1}{1}}$ $P_{\frac{3}{3}}$ $M_{\frac{1}{1}}$. The premolars are very massive and hyæna-like, and have a posterior basal cusp. $\overline{P^4}$ is the largest of all the cheek-teeth (i. e. in the type species) and is nearly molariform. $\overline{M^1}$ appears to have a large sectorial blade and a talon, and $\overline{m^2}$, which is larger, to have neither metaconid nor talon. The mandible is quite feline in shape, but the horizontal ramus is relatively heavier and the masseteric fossa not so deep; the ascending ramus is not so broad as in *Pulæonictis*, indicating a shorter cranium and zygomatic arches.

The type species is *P. ulta* Leidy (*Limnofelis, Oreocyon latidens* Marsh) from the Bridger. A second species, also from the Bridger, is referred to this genus provisionally, ? *P. leidyanus* Wortman, but the compressed character of the teeth renders the reference very doubtful.

HYÆNODONTIDÆ.

Syn. *Oxyænidæ* Cope.

Para- and metacones of superior molars connate or indistinguishably fused, and posterior trenchant blade very large; protocone reduced or absent. Talon of inferior molars and metaconid reduced or absent on one or more teeth; proto- and paraconids enlarged and flattened forming a shearing blade.

The members of this family form one of the most aberrant of the creodont groups and display a great many stages in the reduction

[1] Proc. Acad. Nat. Sci., 1870, p. 10.
[2] Amer. Journ. Sci. and Arts, 3rd Ser., Vol. IV, 1872, p. 203.
[3] Loc. cit., p. 406.

and simplification of the molar teeth, so that the family definition can be framed only in the most general terms. On the other hand, the succession of the genera is so close and the steps of change so gradual, that it seems impracticable to subdivide the group unless each genus be given family rank. The connection of this group with the *Proviverridæ* is very close and the line of separation between them arbitrary rather than natural.

OXYÆNA[1] Cope.

$I\frac{3}{3}$ $C\frac{1}{1}$ $P\frac{4}{4}$ $M\frac{2}{2}$. The incisors are small, except $\underline{i_3}$ which is very large and separated by a diastema from the great tusk-like canine. $\underline{P_1}$ is small and single rooted; the other premolars increase in size and complexity posteriorly; $\underline{p_{2 \text{ and } 3}}$ have developed the deuterocone, and $\underline{p_4}$ is a well developed sectorial, with very large deuterocone and trenchant tritocone, which with the protocone forms a very effective shearing blade, nearly as large as the first molar. $\underline{M_1}$ is the exaggeration of a condition already found in *Sinopa* and its allies; the protocone is somewhat reduced, the para- and metacones very closely approximated and the posterior cutting crest greatly enlarged, forming a sectorial blade. $\underline{M_2}$ is transversely extended and very short antero-posteriorly; it appears to consist of a small paracone and very broad protocone. In the lower jaw $\overline{p^1}$ is one rooted; $\overline{p^{2 \text{ and } 3}}$ have high protoconids and low, pointed talons; $\overline{p^4}$ is similar, but larger and the heel is trenchant. The molars consist of a sectorial blade, formed by the enlarged and flattened proto- and paraconids, with a well developed metaconid; the talon is low, small and basin-like, with continuous margin. The relative size of the molars varies; in some cases $\overline{m^1}$ is the larger and in others $\overline{m^2}$.

The researches of Cope, and latterly those of Osborn and Wortman, have given us almost a full account of the skeleton of this curious genus. The skull is quite feline in appearance, with short face, broad and truncate muzzle and large anterior nares, the zygomatic arches are prominent, heavy and moderately long, and the jugal sends up a strong post-orbital process, partially enclosing the orbit. There is a long and prominent sagittal crest and the cranial walls are thick.

The posterior thoracic and lumbar vertebræ display the creodont type of zygapophyses, and the tail is long and stout.

[1] Rep. Vert. Foss. N. M., U. S. Geog. Surv. W. of 100th Mer., 1874, p. 11.

The humerus has tuberosities of no great size, but the deltoid ridge is remarkably long and prominent; the trochlea is low but broad and has a rounded surface for the capitellum of the radius; the entepicondyle is relatively small, but retains the foramen. The head of the radius is discoidal and the distal end is expanded and bears a carpal facet which is very feline in shape. The distal end of the ulna has also very much the same form as in the cats. The carpus is low and broad, with separate scaphoid, lunar and central elements. The metacarpals, five in number, are strikingly small and weak, as compared with the size of the skull and teeth; they are, however, interlocked in the same elaborate manner as in the cats. The phalanges are depressed and the unguals small, compressed and claw-like, but cleft at the free end.

The pelvis differs from that of the typical creodonts in having an expanded ilium and wide, flattened ischium. The femur has a wide and flat proximal end, and prominent first trochanter, but the digital fossa is small and shallow. The tibia has a broad, overhanging head and the shaft is deeply grooved on its posterior face; the astragalar surface is nearly flat and the inner malleolus prominent. The astragalus has a very slightly grooved trochlea, large neck and convex head, which is directed obliquely inward; distally there is a facet for the cuboid. The calcaneum is short and heavy and especially remarkable for the great obliquity of the cuboidal surface. The navicular is broad and very shallow and is obliquely placed with reference to the axis of the foot. The cuboid is a remarkable bone and its shape is characteristic of the entire family; the proximal surface is unequally divided between a large surface for the calcaneum and a smaller one for the astragalus which meet at right angles; this gives the cuboid a very oblique position and causes the axes of this bone and of the navicular to form an acute angle, instead of being parallel. This divergence is to some extent compensated by the very large wedge-shaped ectocuneiform. The position of the tarsals here described produces a divergent, radiating arrangement of the metatarsals, which like the metacarpals, are all present, but are weak and slender.

Three species: *O. forcipata* Cope, *O. lupina* Cope and *O. morsitans* Cope. Wasatch.

PROTOPSALIS Cope.[1]

Syn. ? *Limnofelis*[2] Marsh.

The name *Limnofelis* is of older date than *Protopsalis*, but was founded upon such imperfect specimens that no generic characters can be derived from them. The probability that both names refer to the same thing is given by the fact that both are very large animals, referable to the *Hyænodontidæ* and occurring in the Bridger beds.

The number of teeth in this genus is not known; an anterior lower molar ($\overline{m^1}$?) resembles that of *Oxyæna*, having a metaconid and fairly large basin-shaped heel; $\overline{m^2}$? however, is strikingly like the inferior sectorial of the cats, except for the greater height and narrowness of the protoconid; the metaconid has disappeared and the talon is a minute rudiment. The skeleton, so far as it is known, closely resembles that of *Oxyæna*, but the bones are much larger, more massive and with more prominent processes for muscular attachment. The cuboid is very peculiar; the calcaneal surface is even larger and more oblique than in *Oxyæna* and is slightly convex, while the astragalar facet, which in the Wasatch genus is nearly plane, is in *Protopsalis* decidedly concave from before backward. The metapodials are relatively stouter than in *Oxyæna*.

One species: *P. tigrinus* Cope (Syn. ? *Limnofelis ferox* Marsh). Bridger.

HEMIPSALODON[3] Cope.

This, the largest of known creodonts, is nearly allied to *Pterodon*, but distinguishable from it by the character of $\overline{m^3}$, which in the latter has a rudimentary trenchant heel, but in the former the talon is larger and basin-shaped, with continuous margin, as in *Oxyæna*; the metaconid is probably absent. This is the only molar the construction of which is known, but the number of teeth in the mandible is known to be: I_3 C_1 P_4 M_3. The canine is exceedingly powerful and the jaw very massive; the chin is deep and abruptly rounded and the symphysis very long, extending to $\overline{p^4}$. The femur is very like that of *Protopsalis*, but has a much longer neck and small hemispherical head; the second and third trochanters are not very prominent and the latter is placed low down on the shaft; the

[1] Amer Naturalist, 1880, p. 745.
[2] Am. Journ. Sci. and Arts, 3rd Ser., Vol. IV, 1872, p. 202.
[3] Amer. Naturalist, 1885, p. 163.

rotular trochlea is short and narrow and the condyles differ from those usually found among creodonts in being closer together, of more unequal size and projecting more strongly backward.

One species: *H. grandis* Cope, from the White River beds of the Cypress Hills, N. W. Territory, Canada.

HYÆNODON Laiser & Parieu.

The dental formula of this genus is: $I\frac{3}{3}$ $C\frac{1}{1}$ $P\frac{4}{4}$ $M\frac{3}{3}$. The upper premolars have high, acute and simple crowns, except $\underline{p_4}$, which has both deutero- and tritocones, though they are considerably reduced, as compared with those in *Pterodon* and *Oxyæna*. The upper molars are greatly simplified by the entire loss of the protocone and the fusion of the para- and metacones, though they can still be distinguished on $\underline{m_1}$; the posterior crest, on the other hand, is greatly developed and thus these teeth form effective sectorials; $\underline{m_2}$ is considerably the larger of the two. The inferior premolars are likewise simple, having, in addition to the very high and acute protoconid, a more or less well developed posterior cusp. $\overline{M^1}$ is much the smallest of the series, and consists of proto- and paraconids, with a rudimentary talon, the metaconid having disappeared; in $\overline{m^2}$ the talon is still further reduced; the proto- and paraconids form a trenchant blade; $\overline{m^3}$ is still larger and has no trace of the talon; it closely resembles $\overline{m^1}$ of the cats.

The skull is typically creodont, with some remarkable specializations. The cranium is long, narrow, of small capacity and with very marked post-orbital constriction; the face is rather short and the large orbits placed very far forward; the upper contour of the skull is nearly straight, parietals and nasals lying in nearly the same plane. The occiput is low and broad, with small paroccipital processes closely applied to the still smaller paramastoids. The frontals enclose large sinuses. The nasal chamber is very high and in consequence the mesethmoid is even larger than in the carnivorous marsupials; the vomer is likewise very long and high and the ethmo-turbinals are well developed and complexly folded. The jugal is rather slender and is applied to the maxillary quite close to the level of the molars. The palate is very remarkable; the palatines are much elongated and in contact almost throughout their length, forming a tube, which opens far back, as a narrow slit, between the hinder end of the palatines and pterygoids; in one species (*H. leptocephalus*) the opening is pushed still farther back by

the junction of the pterygoid plates of the alisphenoids. The cranial foramina are very much as in the dogs, but there appears to be one important and constant difference between the American and European species of the genus, in that the latter possess an alisphenoid canal, which the former have not. In the American forms the horizontal ramus of the mandible is long and slender, gradually deepening posteriorly, and forming a very long symphysis with its fellow; the coronoid is more or less triangular in shape and the condyle is placed very low; the angle terminates in a short hook.

The skeleton, which is very completely known, differs from that of *Oxyæna* only in details and need not be described here, farther than to mention the large articulation between the fibula and the calcaneum. The American hyænodonts have the scaphoid, lunar and central bones all separate, while in the European species they are coalesced.

Four American species of *Hyænodon* have been described: *H. horridus* Leidy, *H. crucians* Leidy, *H. cruentus* Leidy, *H. leptocephalus* Scott, all from the White River.

MIACIDÆ Cope.

Fourth upper premolar and first lower molar forming the single pair of sectorials; superior molars tritubercular, inferior molars, except $\overline{m^1}$, also tubercular.

The members of this family which form the connecting link between the Creodonta and the Carnivora, so far at least as their dentition is concerned, are, unfortunately, as yet very imperfectly known, no complete skull or well preserved feet having been discovered.

DIDYMICTIS[1] Cope.

$I\frac{3}{?}\ C\frac{1}{1}\ P\frac{4}{4}\ M\frac{2}{2}$. The anterior upper premolars are simple, compressed and trenchant cones, without accessory cusps, but P_4 is a fully developed sectorial, the proto- and tritocones forming the blade; the protostyle, which occurs in the cats and viverrines, is also indicated. M_1 is quite large, with the three primary cusps present, though the metacone is much reduced and the metaconule has disappeared, and there is no hypocone; the antero-external angle of the crown is greatly extended and there is a very broad cingulum.

[1] Syst. Cat. Vert. Eocene N. M., U. S. Geogr. Surv. W. 100th Mer., 1875, p. 11.

$\underline{M_2}$ is much smaller than $\underline{m_1}$ and in some species is greatly reduced; it is of simple tritubercular pattern, without hypocone or conules. The lower premolars are much compressed and have posterior cusps. $\underline{M_1}$ has an extremely high trigonid which, however, forms but a primitive sectorial blade, as the paraconid retains its internal position and the protoconid is but little enlarged, except in height, conspicuously exceeding in this respect the other two cusps which are of nearly equal size. Consequent on this arrangement the shearing surface is anterior rather than external; the talon is low and basin-shaped. $\underline{M_2}$ is very much smaller than $\underline{m_1}$ and has a tuberculo crown, but, as Cope has pointed out, this tooth is clearly derived from a tuberculo-sectorial, all the elements of the trigonid being still preserved as small but acute cusps, which rise slightly above the level of the talon.

The skull, so far as it is known, is of the ordinary creodont type, with short tapering face, orbits far forward and deep postorbital constriction. The mandible has a long and narrow horizontal ramus, with very narrow symphyseal portion. The lumbar vertebræ have the creodont type of zygapophyses; the metapophyses and anapophyses are small. The humerus has small tuberosities, a wide bicipital groove and very prominent deltoid ridge; an entepicondylar foramen is present. The ulna has the very high olecranon so general among creodonts; the sigmoid notch is deep, but the humeral facet small; the shaft is very broad. The radius has a transversely oval head, which occupies most of the humeral trochlea. The carpus is very low, the scaphoid and lunar separate, and the unciform shaped as in the viverrines (e. g., *Arctictis*). The pollex is short and relatively rather stout, the other metacarpals much more slender; though proportionately much weaker, the general character of the metacarpals and phalanges is quite like that in the viverrines, and the interlocking of the metacarpals is similar, No. II touching the magnum and No. III the unciform though not by extended surfaces. The ungual phalanges are compressed and sharp and very like those of *Cynogale*, without the cleft at the tips which occurs in nearly all creodonts.

The ilium is short and prismatic. The femur has a slender compressed shaft and a very large 2nd and small but distinct 3rd trochanter. The tibia is long and slender, with gentle sigmoid curvature; the astragalar surface is but obscurely grooved and the large malleolar process has an articular surface upon the distal end. The

astragalus in some species is slightly grooved, in others not at all; the neck is long, the head narrow and not articulating with the cuboid. The calcaneum is short and stout, with very small sustentaculum and prominent process for the cubo-calcaneal ligament. The cuboid is like that of *Cynogale*, but is without the distinct excavation for the navicular. The metatarsals, probably five in number, are very slender and interlocked much as in the viverrines.

Eight species: *D. haydenianus* Cope and *D. primus* Cope, are from the Puerco; *D. protenus* Cope, *D. leptomylus* Cope, *D. dawkinsianus* Cope, *D. massetericus* Cope and *D. curtidens* Cope, are from the Wasatch, while *D. altidens* Cope is from the Wasatch and Bridger.

MIACIS[1] Cope.

Syn. ? *Vulpavus*[2] Marsh, *Uintacyon*[3] Leidy.

Vulpavus is an older name than *Miacis*, but being founded solely upon the upper tubercular molars, it cannot be used, for the exact generic reference of the tubercular molars is at present impracticable.

The dental formula of the mandible is: $I\frac{3}{3}$ $C\frac{1}{1}$ $P\frac{4}{4}$ $M\frac{3}{3}$. The incisors are closely crowded together and the second one is pushed back out of the line of the other two. $\overline{P^1}$ is single rooted and in some species is isolated by a diastema both in front of and behind it, in others the dental series is uninterrupted. In $\overline{m^1}$ the trigonid is of moderate height, and through the flattening of the protoconid a more efficient sectorial blade is formed than in *Didymictis;* the talon is basin-like, with distinct hypo- and entoconids. $\overline{M^2}$ is a "tubercular" molar, but retains all the elements of $\overline{m^1}$. $\overline{M^3}$ is very small and is sometimes implanted by one fang, sometimes by two.

The mandible, the only known portion of the skull, varies from the long and slender jaw of *M. edax* to the relatively short, deep and thick jaw of *M. bathygnathus*, with its steeply inclined and abruptly rounded chin; the masseteric fossa is deep and the angular process a short hook. A few skeletal fragments of *M. bathygnathus* have been found, but as the relations of that species to the others, are very far from clear, the description of these will be omitted.

Six species: *M. parvivorus* Cope, *M.* (*Uintacyon*) *edax* Leidy, *M.* (*Uintacyon*) *vorax* Leidy, and *M. bathygnathus* Scott, are from the Bridger horizon. *M. canavus* Cope has been found in the Wasatch

[1] Proc. Am. Phil. Soc., 1872, p. 470.
[2] Am. Journ. Soc. and Arts, 3rd Ser., Vol. II, 1871, p. 124.
[3] Proc. Acad. Nat. Sci. 1872, [1873], p. 277.

and Wind River, and *M. brevirostris* only in the latter beds. A very doubtful species is the ? *M.* (? *Amphicyon*) *vulpinus* Scott and Osborn, from the Uinta Eocene, which is too imperfectly known for certain reference.

VIVERRAVUS[1] Marsh.

This genus is very inadequately known, but appears to differ from the other members of the family in the mandibular formula: $P_{\frac{3}{3}}$ $M_{\frac{3}{3}}$. $\overline{M^{2 \text{ and } 3}}$ are tubercular, but the trigonid retains all three cusps and rises considerably above the level of the talon. The premolars are much compressed and the mandible long and slender.

Three species: *V. gracilis* Marsh: ? *V. nitidus* Marsh, *V.* (*Limnocyon*) *riparius* Marsh: Bridger.

THINOCYON[2] Marsh.

Not improbably this genus is identical with the preceding one. The mandibular formula is given as: $I_{\frac{3}{3}}$ $C_{\frac{1}{1}}$ $P_{\frac{3}{3}}$ $M_{\frac{3}{3}}$; $\overline{m^{2 \text{ and } 3}}$ are tubercular and the angle of the mandible is said to be reflected.

One species: *T. velox* Marsh, Bridger.

GENERA INCERTÆ SEDIS.

Under this head will be discussed a number of forms which have been referred to the Creodonta, but the nature of which is very problematical.

MIOCLÆNUS[3] Cope.

In his latest paper on the Puerco fauna, Cope refers to this genus no less than twenty-six species, which range in size from that of a black bear to that of a squirrel. The presence in one horizon and locality of so many species of a single genus and with so great a range of size, is, on the face of it, highly improbable, and I believe the genus, as at present constituted, to be an unnatural one. For structural reasons, I have subdivided the group into many genera, some of which have been described above, and others remain to be mentioned. The name *Mioclænus* should be restricted to those forms which agree with the type species, *M. turgidus*, in the extremely broad, low and massive premolars, which equal or exceed the molars in size; these are: *M. turgidus* Cope, *M. opisthacus* Cope, *M. zitte-*

[1] Amer. Journ. Sci. and Arts, 2nd Ser., Vol. IV, 1872, p. 127.
[2] Loc. cit., p. 204.
[3] Amer. Naturalist, 1881, p. 830.

lianus Cope and *M. turgidunculus* Cope, all from the Puerco. The systematic position of the genus is very doubtful, for such premolars are quite unknown among the creodonts, and are entirely like those of the condylarthrous family, *Periptychidæ*. Indeed, *M. opisthacus* was at one time referred to *Hemithlæus*[1]. On the other hand, the structure of the molars is quite different from that of any of the typical Condylarthra, and if, as Schlosser has suggested, it becomes necessary to refer *Mioclænus* to that group, it will form a very distinct family of the order.

PROTOGONODON gen. nov.

Syn. *Mioclænus* Cope, in part.

To this genus I refer as a type species the *M. pentacus* which Cope provisionally incorporated with *Mioclænus*, though directing attention to the resemblance of its inferior molars (superior unknown) to those of the phenacodont *Protogonia*, from which it differs in the simplicity of $\overline{p^4}$, which has no deuteroconid. Certain specimens, however, show rudimentary indications of it. I think there can be no doubt that this genus is referable to the *Phenacodontidæ*. A second species, *P.* (*Mioclænus*) *lydekkerianus*, the structure of $\overline{p^4}$ in which is not known, probably belongs to the same genus. Puerco.

PARADOXODON gen. nov.

Syn. *Chriacus* Cope, in part.

This curious form, the systematic position of which is altogether uncertain, is known only from inferior molars, though the alveoli of the premolars indicate that these teeth were extremely compressed and recall in their proportions those of the primitive artiodactyls; the molars also suggest relationship to that group. The latter increase in size from the first to the third and the trigonid rises very little above the talon. In $\overline{m^1}$ the proto- and metaconids are of about the same size and on the some transverse line; they are both compressed and the protoconid shows a tendency to become crescentic; the small paraconid is placed immediately in front of the metaconid from which it is separated by a slight notch, while a low ridge connects it with the protoconid; the hypoconid is also somewhat crescentic, the entoconid lower and more conical. In $\overline{m^3}$ the trigonid is curiously asymmetrical, which is caused by the backward inclination of the metaconid, the larger size of the paraconid than

[1] Tert. Vert., p. 407.

in $\bar{m}^1$ and the greater prominence of the ridge connecting this element with the protoconid; the hypoconid is somewhat crescentic and the entoconid reduced, the valley opening inward in advance of that cusp; the hypoconulid is much enlarged and carried on a distinct fang. It would require but relatively little alteration to convert this tooth into one of true selenodont pattern.

One species: *P.* (*Chriacus*) *rütimeyeranus* Cope. Puerco.

CARCINODON gen. nov.

Syn. *Mioclænus* Cope, in part.

This genus is almost certainly unguiculate, but whether creodont or insectivorous is not clear, the character of the lower molar teeth somewhat resembling those of the Wasatch *Diacodon*. $\bar{P}^3$ and ^{4} have high and pointed protoconids and minute posterior basal cusps. The inferior molars increase in size posteriorly and when viewed from the side, the trigonid is seen to curve forward and the talon backward, which gives the crown a claw-like shape. The proto- and metaconids are joined for most of their height and of equal size, and the small but elevated paraconid is placed close to the latter, but connected with the former by a crest; the talon is a deep basin, with elevated margin, upon which the hypo- and entoconids and the hypoconulids appear as small tubercles. In $\bar{m}^3$ these elements, especially the latter, are enlarged.

One species: *C.* (*Mioclænus*) *filholianus* Cope. Puerco.

The species, *Mioclænus* (*Deltatherium*) *interruptus* Cope, *M. minimus* Cope and *M.* (*Hyopsodus*) *acolytus* Cope should, for reasons already stated, be removed from that genus, but are too imperfectly known for proper reference. The latter (*M. acolytus*) may possibly be a forerunner of the Wasatch artiodactyl, *Pantolestes*.

Another group of problematical genera is that constituted by *Onychodectes*[1] Cope, *Conoryctes*[2] Cope and *Hemiganus*[3] Cope, which are distinguished, among other things, by the remarkable thinness of the enamel which covers the molars. It is probable that these forms should be removed from the creodonts and as Cope has suggested, brought into relation with the tillodonts.

[1] Trans. Am. Phil. Soc., Vol. XVI, Pt. II, p. 317.
[2] Proc. Am. Phil. Soc., 1881, p. 486.
[3] Amer. Naturalist, 1882, p. 831.

OCTOBER 4.

Mr. CHARLES MORRIS in the chair.

Twenty-eight persons present.

Papers under the following titles were presented for publication:—

"The Batrachia and Reptilia of North Western Texas," by E. D. Cope.

"On a Collection of Batrachia and Reptilia from Washington and British Columbia," by E. D. Cope.

"Notes on a Collection of Shells from the State of Tabasco, Mexico," by Henry A. Pilsbry.

Geology of the Isles of Shoals.—Mr. THEODORE D. RAND remarked that Hitchcock, in his Geology of New Hampshire, devotes but a few lines to these islands, stating that their geology has been neglected.

They are evidently the remains of a single island eroded by the Atlantic Ocean and are composed of gneissoid rocks with a number of trap dykes.

The rock is chiefly a coarse orthoclase-muscovite gneiss, of which the orthoclase constitutes probably eighty per cent, the quartz less than twenty and the muscovite probably not over two per cent. Inter-stratified in this coarse gneiss is a fine-grained variety containing much more mica and usually of a dark gray color. In some places this contains serpentine veins of orthoclase, in this as well as in other respects resembling our Manayunk schists and gneisses. Garnets, while not entirely absent, are quite rare, and the rock very rarely approaches a schist. The strike is pretty uniform, about N. 70 E., while the dip varies, though usually 70° to 90° N. W. Through these rocks pass numerous joints, many of them very irregular. Along these joint-planes erosion has taken place leaving a very rough and irregular surface, the remaining rock being hard and not much disintegrated.

Crossing the islands in a general northeast and southwest direction are trap dykes of varying width, from one to ten feet. These form special lines of erosion, and are invariably lower than the adjacent gneiss, though apparently much harder. All exposed masses seem fresh and undecomposed.

Most remarkable among these is one at the southeast end of Star Island. It is about six feet across and extends at an acute angle from the south to the east shore. Its strike is N. 35 E., its dip 85° to 90° N. W., with two sets of joints, one parallel to the dip, the other nearly coincident with the stratification of the adjacent gneiss. At each end the dyke was deeply eroded and the adjacent gneiss in

great masses had fallen in, forming at one point one of the places of historical interest known as Betty Moody's Cave. The length of this dyke from shore to shore is probably five hundred feet, but of this about two hundred feet have been eroded to sea level. In the middle the trap is about ten feet below the gneiss walls; to the south it descends by a series of steps quite abruptly and between vertical walls of the gneiss probably fifty feet to the sea.

The present erosion continuing, this southeast end of the island will be cut off entirely and form a separate island of the group. At other points the same action may be seen.

Two phenomena were observed for which no easy explanation offers. The dark, fine-grained gneiss was usually rather regularly inter-stratified in the more abundant coarse granitoid gneiss, but at a number of points it was observed abutting upon the gneiss in the direction of the strike, but without the slightest evidence of a fault. At one point on Appledore Island there was a stratum of the dark variety, thirty feet wide; suddenly, and almost at a right angle, twenty feet of this were replaced by the coarse granitoid rock, while the remaining ten feet went on as before. A clue to the explanation was seen on Appledore, where a stratum of the fine-grained was separated from a larger mass of the same of darker color by a foot or two of the coarse feldspathic rock, which also bounded it on the further side. This stratum had, in about forty feet, five constrictions, narrowing it from three feet or more to hardly as many inches in one place.

The other feature was a form of erosion which he had never before seen. On the horizontal or slightly inclined surfaces of the nearly vertical, fine-grained gneiss were numerous holes, from the size of a small pea to that of a cherry. The gneiss was hard and undecomposed. These pits were roughly globular and were generally larger below than at the opening. They appeared to enlarge and coalesce, thus breaking down the rock, bearing a slight resemblance, on a very small scale, to the pot holes of a river bottom. These were high above the sea. They appeared somewhat as if a mineral, like garnet, had weathered out, but there are no such minerals in the rock, and the holes show no evidence of such; they are quite rough on the inside and hence have not been bored. Their position is such that only ocean spray and rain water could reach them. They are quite abundant.

On the Permanent and Temporary Dentitions of certain Three-toed Horses.—Professor COPE described the changes in the characters of the superior molars of *Protohippus placidus* Leidy, resulting from age and wear, and the characters of the dentition of colts of *Protohippus* and *Hippotherium*. He pointed out that in stages of wear up to middle life *P. placidus* is the *Hippotherium gratum* of Leidy, and that then the protocone fuses with the paraconule, and the animal becomes a *Protohippus*. He had not observed this to take

place in any other species referred to *Hippotherium*. In both these stages the enamel borders of the lakes are more or less plicate, and the posterior loop of the anterior lake is present. With further wear the plications, including the loop, disappear, when the molars agree in their characters with *Protohippus parvulus* Marsh. These observations were based on specimens from the Loup Fork beds of Nebraska, Kansas, Colorado and Texas, where the species is abundant.

The speaker exhibited the molar dentitions of three colts from Wyoming and Texas, and a part of one from Colorado, all from the Loup Fork beds. He showed that these represent the genera *Merychippus*, *Parahippus*, *Hypohippus*, and *Anchippus* of Leidy, and six species of the same author. He thought it probable that *Anchippus* belongs to a colt of *Hippotherium*, and *Parahippus* and *Hypohippus* to *Protohippus*, while he was not certain as to the reference of the type of *Merychippus* (*M. insignis*). He pointed out that the characters of the individual temporary molars differ in the different teeth of the series, and also differ at different stages of wear. As with the permanent dentition, in some species the temporary molars are always simple, while in others the enamel borders are more complex. In the latter case the pattern becomes more simple in some respects with prolonged wear. He was able to correlate the temporary and permanent dentitions of *Protohippus perditus* Leidy with certainty, and those of *P. pachyops* Cope and *P. mirabilis* Leidy with much probability.

Professor Cope further pointed out that the temporary dentition in these three-toed horses is more simple than that of the adult, in some cases resembling very closely the permanent dentition of the ancestral *Anchitherium* in molar structure. In this the horses differ from the higher Artiodactyla, where the temporary molars are equally complex or more so than the permanent molars.

October 11.

Mr. Charles Morris in the chair.

Forty-three persons present.

A Hyena and other Carnivora from Texas.—Prof. E. D. Cope stated that he had during the past season while exploring the eastern front of the Staked Plains of Texas with a party of the Geological Survey of that State under Prof. W. F. Cummins, obtained the remains of some interesting Carnivora from the Blanco or Pliocene beds. One of these is a hyena nearly allied to the genus *Hyæna*, and the first species of this family found in America. It, however, differs from the typical genus in having a fourth premolar in the lower jaw, and probably in having a shorter blade of the sectorial tooth in the upper. He proposed the name *Borophagus* for the genus, and for the species the name *diversidens*. The third premolar

is very large and robust, greatly exceeding the fourth in dimensions. The latter is low and molariform; the inferior canine is large. The measurements are as follows. Transverse diameter of canine alveolus 13 mm.; do. of posterior alveolus of pm. iii, 13 mm.; diameters of pm. iv; longitudinal 4 mm.; anteroposterior 10; transverse 8. Diameters of pm. iii; longitudinal 17 mm.; anteroposterior (partly restored) 28; transverse 15. The species is as large as the spotted hyena and was the scavenger of the Blanco Fauna.

Another interesting carnivore is a weasel of a new genus and species, which it was proposed to call *Canimartes cumminsii* after its discoverer. The genus *Canimartes* is allied to *Mustela*, differing only in the presence of two superior true molars. Metaconid of inferior sectorial well developed; talon of the same, trenchant. The species is as large as the fisher.

A third carnivore is a cat, provisionally referred to the genus *Felis* under the name of *F. hillianus*, after Prof. Robert T. Hill the well-known geologist. This cat is about the size of the cheetah, and has large canine teeth without grooves, and the feet are shorter than in modern cats.

On Hippa emerita.—Dr. Benjamin Sharp exhibited dried specimens of *Hippa emerita* Linn. and called attention to the method of preparation. The animals, as soon as possible after capture and while yet alive, were placed in a 50% solution of corrosive sublimate and allowed to remain there for two days. They were then taken out, washed for a moment in pure water, and then dried. The advantage claimed was that the colors are very well preserved, which would not be the case had they first been placed in alcohol. He further called attention to the habits of this species, popularly known as the "mole crab," or "sand flea" and spoke of the mistake which some authors had made in stating that the animal burrowed into the sand head first. A. F. Verrill[1] says:—"but this species [*Hippa talpoidea*], burrows like a mole, head-first, instead of backward." A. Heilprin[2] remarks:—"the animal [*Hippa emerita*] is a remarkably rapid burrower, pushing itself head downward by means of its anterior or thoracic feet." Dr. Sharp called attention to the fact that the posterior pair of thoracic feet are bent upwards over the posterior part of the carapace and resemble, on superficial observation, antennæ. This has probably caused the posterior part of the animal to be mistaken for the anterior. He had carefully observed the method of burrowing of these animals during the last summer. The posterior feet were employed in loosening the sand by their rapid motion; the other limbs working forward push the animal backward into the sand, a method of progression common, more or less, to all decapods. He further called attention to the

[1] Report of the Invertebrates of Vineyard Sound, etc., Washington, 1873, 338 and 339.

[2] The Animal Life of our Sea Shore, Philadelphia, 1888, p. 95.

ovoid shape of these animals, claiming that this was an advantage in enabling them to escape from some of their enemies, the birds, for example, finding the same difficulty in picking them up as is encounted in using the forceps for the same purpose on the specimens.

OCTOBER 18.

Mr. CHAS. P. PEROT in the chair.

Forty-seven persons present.

A New Marine Gasteropod from New Jersey.—MR. H. A. PILSBRY exhibited a series of specimens of a large species of *Chrysodomus*, belonging to the subgenus *Sipho*, which he had received from Messrs Witmer Stone, Chas. LeRoy Wheeler and John Ford. He stated that the specimens were cast upon the shore during severe gales from the south east, and were evidently derived from a submarine stratum which was disturbed and broken up at those times. Associated with the *Chrysodomus* were examples of *Buccinum undatum*, *Urosalpinx cinereus* of extraordinary dimensions, and *Chrysodomus* (*Sipho*) *Stimpsonii*, the latter being well developed and typical in sculpture. The age of the deposit cannot definitely be settled at present, but the evidence at hand indicates that it is post-pliocene.

The following description of the new species was offered:

CHRYSODOMUS (SIPHO) STONEI (Pl. XIV, figs. 1, 2, 3,). Shell obese-fusiform, rather thick and solid, with strongly convex whorls separated by deep sutures. Sculpture consisting of strong spiral cords, equal on young specimens and on the spires of adults, but which alternate with smaller intermediate cords on the body-whorl in full grown specimens. A young shell, therefore, has about 20, an adult 40 spirals upon the body-whorl. The aperture is oval; the canal is strongly curved to the left and backward.

Length 72, greatest diam. 45 mm.; length of aperture and canal 51 mm. The largest individual measures, length 100, breadth 64, length of aperture 73 mm. Both of these, as well as all specimens seen, have lost several of the earlier whorls; so the length of a perfect individual would be proportionately greater.

The more prominent features of this species are the swollen form, deep sutures, the strong spiral sculpture, and the strongly recurved canal.

The localities from which specimens have been obtained are as follows: Point Pleasant, N. J. (Witmer Stone); Sea Isle City, N. J. (John Ford, Oct., 1892); Cape May, N. J. (C. LeRoy Wheeler, 1891.)

Prof. A. E. Verrill of Yale College very kindly compared specimens of this species with the collection under his charge (a collection vastly richer than any other in mollusks of the north-west Atlantic.) He writes as follows:

"I have made a careful comparison of the *Sipho* sent by you with our series.

"It differs notably from anything we have, and is probably, as you suppose, an undescribed species, unless described as a fossil. We have specimens of the ventricose varieties of *S. Stimpsoni*, which equal this in stoutness, and nearly equal it in curvature of the columella, but the whorls are less ventricose, the shoulder less swollen, the sutural region less deep, and the sculpture is very much finer."

Comparisons have also been made by myself with the Atlantic Siphos in the U. S. National Museum, and of course with the recent and fossil series in the collection of the Academy.

Diachæa Thomasii, a New Species of Myxomycetes.—Dr. Geo. A. Rex presented specimens of a species of *Diachæa* which he considered new and undescribed.

This species was first found by Mr. Lancaster Thomas at Cranberry in the mountains of Western North Carolina, and later by the speaker at Linville higher up in the same mountains. In both cases the *Diachæa* was first found in the plasmodial stage. Owing to the altitude of these places, 3,200 and 3,800 feet respectively, the temperature even in July and August frequently falls at night nearly or quite to the lowest point compatible with the life of the plasmodium or with its further development to maturity. By careful protection, however, perfectly mature sporangia were developed.

The sporangia are beautiful and conspicuous, hence the speaker was inclined to believe the species local in its habitat, else it could not have escaped attention up to this time in view of the increasing interest taken by students in the study of these forms. The species may be described as follows:

Diachæa Thomasii n. sp. Plasmodium ochre yellow, immature sporangia pure white, mature sporangia of a metallic lustre either silvery or gold bronze partially iridescent; growing either singly or in clusters, stipitate or sessile, globose when stipitate but flattened beneath when sessile; $\frac{1}{2}$ to $\frac{2}{3}$ of a mm. in diameter. Stipes variable, usually short but sometimes equalling the diameter of the sporangium, thick, rugose, dull ochre yellow in color, containing lime. Columellas ochre yellow, rough, penetrating from $\frac{1}{4}$ to $\frac{1}{2}$ the height of the sporangia, varying from bluntly conical to cylindric-clavate in shape, containing minute round or oblong granules of lime. Spores brown, 11–12 μ in diameter, with a peculiar warting, the entire epispore, when examined by a medium power lens being sparsely covered with minute papillæ associated with from six to eight large scattered warts or papillæ apparently, which are resolved however by a sufficiently high amplification into clumps of from five to eight minute, closely aggregated papillæ.

Capillitium sparse, brown violet in color composed of rigid, straight, tapering threads arising from the columella and base of the sporangium, joined by a few lateral branches in the middle and near

the ends into a loose open network; threads from 3–7 μ in thickness at basal point of attachment tapering to a point at their attachment to the sporangial wall.

Hypothallus ochre yellow, calcareous, thick and continuous when the sporangia are sessile, but scanty when they are stipitate.

OCTOBER 25.

The President, GENERAL ISAAC J. WISTAR, in the Chair.

Sixty persons present.

The following were elected members:—

Wm. L. Du Bois, Ann May Whartenby, John T. M. Cardeza, M. D., Samuel Castner, Jr., Mary Vaux, George M. Woodward, Aldrich J. Pennock, Philip P. Calvert, Thomas Earle White, Ralph F. Cullinan, John A. Shulze and George Vaux, Jr.

The following were ordered to be printed:—

THE BATRACHIA AND REPTILIA OF NORTH WESTERN TEXAS.

BY E. D. COPE.

The present paper is based on collections made along the eastern border of the Staked Plain of Texas, between Big Spring (on the Texas Pacific R. R.) on the south, and the Salt Fork of the Red River, near Clarendon (on the Denver and Fort Worth R. R.) on the north, a distance of about 250 miles. The collections were made incidentally to geologic and paleontologic explorations conducted by a party of the Geologic Survey of Texas, which was under the direction of Mr. William F. Cummins. While attached to this party, I picked up such specimens as came in my way, and a good many others were obtained by Mr. Cummins and by Mr. William L. Black of the party.

The region traversed presents great variety of landscape, plains alternating with hilly country, and in some cases with bad lands. Water issues at many points from beneath the superficial cenozoic beds of the Staked Plains, forming the head tributaries of the Colorado, Brazos and Red rivers. This water, however, generally soon disappears beneath the sand that fills the beds of the creeks and rivers, or appears only in pools. Under such circumstances it is frequently impregnated with saline and alkaline salts. The springs are generally the resort of the numerous cattle that graze in this region, and when this is the case, are so contaminated by their presence as to be unfit for human use. Dead cattle were common in the few flowing streams at the time of my visit, so that it became necessary to dig for a supply of water which should be partially relieved of impurities by filtration. The best water, apart from a few protected springs, was obtained from artificial reservoirs filled with rain water, which are made by the owners of cattle-ranges for their stock. In these, turtles, batrachians, water-snakes, are not uncommon. The route of the expedition followed the eastern escarpment of the Staked Plain, but at times crossed its spurs, or entered its limits for twenty or thirty miles.

The total number of species enumerated is thirty-three. These are distributed as follows. Batrachia: *Urodela*, 1 species; *Salientia*, 7 species. Reptilia: *Testudinata*, 5 species; *Lacertilia*, 8 species; *Ophidia*, 12 species. A comparatively small number of species are

found on the level surface of the Plain; the greater number being derived from the region bordering it on the east, or the two great canyons which traverse it. These are the Canyon Blanco, from which issues the principal head stream of the Brazos; and the Canyon Paloduro, which is traversed by the Prairie Dog head of the Red river. The Tule Canyon is a branch of the latter.

This paper may be regarded as supplementary to one published as Bulletin No. 17 of the U. S. National Museum in 1880, "On the Zoological Position of Texas."

BATRACHIA.

URODELA.

Amblystoma tigrinum Green.

This species is extremely abundant, according to Mr. Cummins, in some permanent lakes on the Staked Plain near the Tule Canyon. Numerous specimens were obtained at this locality, but I could not find this or any other species of salamander elsewhere throughout the region explored, although I examined carefully a number of suitable localities. Mr. Cummins had previously obtained specimens from a well which was sunk in the Staked Plain near Canyon Blanco, and which either had a subterranean origin, or they were hatched from eggs carried to the locality, as the latter was without water prior to the sinking of the well. I obtained a specimen at Big Spring which was said to have been taken in the neighborhood.

SALIENTIA.

Bufo debilis Girard.

This species is rather abundant throughout the region traversed. It is frequently found in the grass, where its green color aids in concealing it. When in the water, its cry is like that of *B. lentiginosus americanus*, but is more feeble, and very "nasal."

Bufo cognatus Say.

First seen near the head waters of the Brazos, but not common south of Tule Canyon.

Bufo lentiginosus Shaw. var.

A large specimen was obtained near Clarendon. The head is one-fifth the length, as in *B. l. woodhousei*, but the cranial crests are as in *B. l. americanus*. Not seen south of this point.

Acris gryllus Lec.

Common wherever there is water.

Chorophilus triseriatus clarkii Baird.

Less abundant than the preceding, but found throughout the entire region as far north as explored. The spotted coloration is constant. They sit immersed in the water, with the head projecting, uttering their cry, as they inflate the enormous vocal sac, to which the head appears to be but an appendage. The voice differs from that of the form *triseriatus* in its more rapid utterance, and the greater distinctness of the rising inflection at the end.

Spea hammondii bombifrons Cope.

Abundant near Canyon Tule (Cummins); not seen elsewhere except near Clarendon, where I took one from the mouth of a *Heterodon nasicus*.

Rana virescens brachycephala Cope.

Found everywhere at water; the only species of the genus.

REPTILIA.

TESTUDINATA.

Cistudo ornata Agass.

Abundant on high land. Observed in copula in May.

Chrysemys elegans Wied.

Found in all permanent springs, and along streams, often where it has little concealment owing to the shallowness of the water. It often lies partly hidden in mud, and in deeper water, bites the fisherman's hook.

Chelydra serpentina L.

Reported by Mr. Cummins from the head waters of the Brazos.

Kinosternum flavescens Agass.

An abundant species in the region traversed, and represented in my collection by an adult male, and two adult and one young females. The characters are in general those of the *C. flavescens* Agass., but in some respects it differs from the type specimen. The carapace, though depressed, is a longitudinal oval, the posterior lobe of the plastron is wider than long, and the inguinal region is but shallowly grooved. It agrees with *C. flavescens* in having the superior anterior angle of the antepenultimate marginal scutum produced upwards so as to notch deeply the penultimate costal

scute, and in having but a narrow line of contact between the first and second vertebral scuta. It differs from the type of the species in having the pectoral scuta cut off from contact with each other by the posterior direction of the humero-pectoral sutures, which reach the pectoro-abdominal, a character present in all of the adults. It results from this that the gular scute does not extend half way to the end of the median humeral scuta, as it does in the type specimen. Posterior lobe of plastron notched posteriorly. One inguinal and one axillary scutum, in contact with each other. Penultimate marginal scutum twice as high as the last one posteriorly, and encroaching on the pygal and last costal plates. Nuchal plate small; no trace of dorsal keels, muzzle oblique, the apex projecting. The color of the carapace is olivaceous, and of the plastron brownish-yellow or yellowish-brown. The skin is lead-colored except the jaws, chin, throat, and anterior face of fore legs, which are light-yellow. Male with numerous rather obscure small brownish spots on sides of head and maxillary region. Length carapace ♂, 140 mm.; width 95 mm. length of plastron 110 mm. Length carapace ♀ 102 mm.; width 76 mm.; length plastron 92 mm.

This species is especially abundant in the artificial "tanks" of the cattle ranges, and in temporary pools of rain water. Its muzzle may be frequently seen projecting from the water, and it is an active swimmer. As the pools approach desiccation these turtles make their way over land to other localities. The male in my possession was an inhabitant of a small pool at which we camped for two days, but he took his departure for a more permanent habitation on the day that we left. We overtook him on the road, still covered with fresh mud.

Trionyx emoryi Agass.

Abundant in all permanent water.

LACERTILIA.

Eumeces obsoletus B. & G.

Not seen living by me, but obtained at Big Spring near which place it was said to have been caught.

Cnemidophorus gularis gularis B. & G.

Cope, Transac. Amer. Philos. Soc., 1892, p. 43–5.

The common swift of the country, very abundant, and showing no variation of color. We did not see it north of Holmes' creek, which is a tributary of the Red River south of the Prairie Dog creek.

Cnemidophorus grahamii B. & G.

Two specimens of this rare species were obtained by Mr. W. L. Black near the Tule Canyon. The pattern of coloration is like that of *C. tessellatus tessellatus*, or *C. gularis scalaris*, except that it has a median dorsal zigzag light stripe.

Holbrookia maculata B. & G.

Abundant everywhere, but chiefly on the open prairie.

Holbrookia texana Trosch.

Abundant in rocky ground.

Crotaphytus collaris Say.

Abundant, generally in rocky ground.

Phrynosoma cornutum Harl.

Abundant, especially on the Staked Plain. Not seen north of Clarendon.

Phrynosoma modestum Gird.

Rather abundant as far as Clarendon; Tule Canyon. General Pope sent this species to the National Museum from the Staked Plain, and once from the head-waters of the Colorado, of Texas, but I had no expectation of finding it so widely distributed on the eastern side of the Staked Plain. It is a species of the Sonoran fauna.

OPHIDIA.

Contia episcopa episcopa Kenn.

From the Colorado to the Salt Fork of the Red River; not very common. In life the vertebral line is orange colored.

Contia episcopa isozona Cope.

One specimen from Tule Canyon; W. L. Black.

Ophibolus getulus sayi Holbr.

One specimen from Tule Canyon; W. L. Black.

Pityophis sayi sayi Schleg.

The largest snake of the region and generally distributed.

Bascanium flagelliforme Catesby.

The most abundant snake of the country. Although belligerent when attacked, this species soon becomes perfectly tame, and seems to be subject to some kind of hypnotization. The head is held rigidly forward at an angle with the body, and it is difficult to make it modify the position.

Heterodon nasicus nasicus B. & G.

Found to be abundant in sandy soils from the heads of the Brazos as far north as we went.

Heterodon platyrhinus Latr.

One specimen from Tule Canyon; W. L. Black.

Eutænia proxima Say.

Specimens nearly as black as Mississippi valley specimens, from Tule Canyon; W. L. Black.

Eutænia elegans marciana B. & G.

Tule Canyon; W. L. Black.

Natrix fasciata transversa Hallow.

Common throughout the entire region, and constant in its characters.

Crotalophorus catenatus edwardsii B. & G.

One specimen from Quana, Hardeman Co. on the upper Red River; W. L. Black.

Crotalus confluentus confluentus Say.

Abundant on the Staked Plain as far south as Canyon Blanco, and on the lower country on the head-waters of the Red river. This rattlesnake is abundant in prairie dog villages, as it protects itself by retreating quickly into their holes when approached.

Crotalus adamanteus atrox B. & G.

At the foot of the Staked Plain about the heads of the Colorado. Not met with on the Plain, or north of the region mentioned.

Observations.

The preceding list is remarkable from the absence of any species of the genus *Sceloporus*, of which none were seen by the expedition. This is due to the scarcity of timber, where they are generally found in Texas. The terrestrial species of Mexico and of the Great Basin do not appear to occur in this region.

Another peculiarity is the great scarcity of individuals and species of *Eutænia*. I saw but one specimen during the expedition, and this I did not obtain.

As the point of junction of the Texan district with the Central and Sonoran Regions, the country explored deserves especial attention. Enough is, however, not yet known of the distribution of many of the species found within the political limits of Texas to

enable us to reach final conclusions. It is, however, evident that the boundaries of the zoological district of Texas do not extend east of Dallas.

The only exclusively Texas forms of the above list are the following: *Chorophilus triseriatus clarkii* Bd., *Kinosternum flavescens*[1] Ag., *Trionyx emoryi* Ag., *Holbrookia texana* Trosch., *Phrynosoma cornutum* Harl., *Contia episcopa episcopa* Kenn., *Natrix fasciata transversa* Hallow., *Crotalophorus catenatus edwardsii* B. & G.; that is, four species and four subspecies. Species of the Louisianian district: *Ophibolus getulus sayi* Holbr. and *Eutænia proxima*. Species of the Sonoran region and Texan district, three: *Bufo debilis* Gird., *Crotaphytus collaris* Say, *Crotalus adamanteus atrox* B. & G. Species of the Sonoran entering the list: *Cnemidophorus gularis gularis* B. & G., *Phrynosoma modestum* Gird.; two species. Species of the Central Region are more numerous, viz.; *Bufo cognatus* Say, *Spea hammondii bombifrons* Cope, *Chrysemys elegans* Wied., *Holbrookia maculata* B. & G., *Pityophis sayi sayi* Schl., *Heterodon nasicus nasicus* B. & G., *Crotalus confluentus confluentus* Say; total, three species and four subspecies. Synoptically the results may be tabulated as follows.

	species	subspecies
Texan,	4	4
Central,	4	2
Texan and one other region,	6	7

Other species of the list not included in these figures, have a still wider distribution.

It seems from the above, that the region explored is the meeting ground of species of several different regions, as its geographical position would indicate.

[1] This species may also occur in the Sonoran region.

NOTES ON A COLLECTION OF SHELLS FROM THE STATE OF TABASCO, MEXICO.

BY HENRY A. PILSBRY.

The Academy has received during the past summer, several parcels of land and fresh-water mollusks collected by Professor José N. Rovirosa, mainly in the State of Tabasco, Mexico. As a portion of them are of considerable interest, the writer has drawn up the following list.

Glandina ghiesbreghti Pfr.

San Juan Bautista, Tabasco.

Streptostyla nigricans Pfr.

Mountains of Poana, Tabasco.

Eucalodium compactum n. sp. (Pl. XIV, fig. 4.)

Shell cylindrical-tapering, solid, having a short, closed umbilical chink; the cuticle thin, evanescent, very pale straw colored; composed of 9 narrow, somewhat convex whorls, which are rather strongly striated, the striæ arcuate, irregular in places, and from one-half to one-third of a millimeter apart except on the last whorl where they are closer; last whorl angular in front of the upper angle of the aperture, becoming well rounded but retaining a trace of the peripheral angle on its latter half. Aperture oblique, irregularly ovate; peristome continuous and free from the preceding whorl, well expanded; columella having an obsolete fold. Internal axis having a strong spiral fold. Alt. 53, diam. 19½ mill.

Tabasco, Mexico.

Cylindrella morini Morel.

Mountains of Poana, Tabasco.

Ampullaria ghiesbreghti Reeve.

San Juan Bautista, Tabasco.

Chondropoma rubicundum Morel.

Mountains of Poana, Tabasco.

Cyclophorus maleri Crosse & Fischer.

Mountains of Poana, Tabasco.

Cyclotus dysoni Pfr.

Mountains of Poana, Tabasco.

Helicina ghiesbreghti Pfr.

Mountains of Poana, Tabasco.

Helicina oweniana Pfr. var.

A rather aberrant variety, but in all probability this species. Poana, Tabasco.

Helicina tenuis Pfr. var. **chiapensis** Pfr.

Poana, Tabasco.

Unio semigranosus Busch.

Rio Tulija, Tabasco.

Anodonta globosa Lea.

A very large specimen, measuring 182x136x92 mill.
San Juan Bautista, Tabasco.

The splendid work of Crosse and Fischer upon the genus *Pachychilus* enables me to readily classify the specimens collected by Prof. Rovirosa; the illustrations of the varieties of *P. glaphyrus* are especially valuable.

Pachychilus glaphyrus Morelet.

This species is an exceedingly variable one, more so perhaps than any other Mexican Melanian. The American student, however, will readily call to mind cases of equal variability among the species of our Southern States. The material sent by Prof. Rovirosa comprises a number of varietal forms not before made known.

P. glaphyrus Rovirosai Pils.

This was figured and described under the name *P.* (*polygonatus* var.?) *Rovirosai* in the Proceedings, 1892, p. 153, Pl. VIII, figs. 9, 10. I was at that time not aware of the fact that Morelet's name *glaphyrus* antedated that given by Lea, *polygonatus*. This form is allied to *P. glaphyrus* typical, and to the var. *scamnata*, but it is distinct from both. The form is notable for its stout, straight-sided spire, non-impressed sutures, and the unsculptured young.

P. glaphyrus var. between **polygonatus** and **immanis**. (Pl. XIV, figs. 5, 6.)

The two specimens figured are of the same size but differ in sculpture. One (fig. 6) is smooth above and below, having a strong subspinous keel at the periphery, and a smooth, acute keel below it. Upon the earlier whorls of the spire there are longitudinal waves, and two spiral cords above the peripheral keel, which diminishes in size. The base has no spirals. The other specimen has the

entire body-whorl spirally lirate (liræ on body-whorl 9, on penultimate whorl 3) and strongly plicate.

P. glaphyrus potamarchus. (Pl. XIV, fig. 7.)

This is one of the largest forms of *Pachychilus* known, and it is the most aberrant of the *glaphyrus* stock. The shell is rather slender and acutely conical, the outline of the spire being straight. The aperture is ovate, narrowed above, and one-third the length of the shell. Whorls 10–11 remaining, several of the earlier being lost by erosion. The microscopic sculpture is the same as in var. *Rovirosai*. There are no traces whatever of the waves or folds so prominently shown by the other varieties of *glaphyrus*, and the spiral cords are also completely obsolete, or indicated by the faintest traces on the base. The color is olive-green or olive-brown.

Alt. 99, diam. 33 mill.

Alt. 87, diam. 29 mill. Tabasco, Mexico.

This variety differs from the *pyramidalis* of Morelet in being larger and smoother, lacking altogether the chestnut colored spirals of that form.

P. chrysalis Brot.

The specimens are large (alt. 60, diam. 27 mill.; alt. of aperture 25 mill.) and have nearly perfect apices. They were collected at Ixtacomitan, Chiapas, where they are called "*Shote.*" There can be little doubt that *P. larvatus* Brot is a synonym of *chrysalis*.

P. corvinus Morelet.

The specimens were collected at the Montanas de Poaná, Tabasco. They differ from Crosse and Fischer's figures in having the callus at the upper termination of the inner lip much heavier.

Pachychilus n. sp.

This is a form resembling closely in contour and sculpture the *P. subexaratus* C. & F. and also *P. largillierti* Phil., but differing from both in possessing an extremely heavy deposit of callus at the upper termination of the inner lip. The specimens were collected on the mountains of Poana, state of Tabasco. As none having the cuticle preserved are at hand, I refrain from giving a full description or name.

Potamanax subgen. nov.

Shell solid, oval with short conic spire, spirally sculptured or banded. Aperture ovate, acute above, broadly rounded below;

outer lip not sinuous; inner lip more or less heavily calloused, not notched at the base. Operculum few-whorled, with basal nucleus. Type *P. Rovirosai* Pils.

This group has the sculpture of *Hemisinus* but differs from that genus in the entire, un-notched basal lip. The columella callus is much like some species of *Pachychilus* but the operculum is very different from that genus. From both of these groups it differs in the short, ovate contour of the shell. The description of the operculum is taken from *Melania brevis* d'Orbigny of Cuba, which I consider congeneric.

P. Rovirosai n. sp. (Pl. XIV, figs. 8, 9.)

Shell oblong-conic, very solid, whitish, encircled by numerous narrow smooth spiral liræ of a dark brown color, and somewhat alternating in size. Spire conical, apical whorl eroded; whorls 5 remaining, slightly convex, the last whorl large, regularly convex. Aperture a little less than half the length of the shell, ovate, angular above; outer lip regularly arcuate; inner lip strongly calloused.

Alt. 20, diam. 12 mill. (old specimen.)

Alt. 16½, diam. 9¾ mill. (young specimen.)

Two specimens are before me, collected by Prof. Rovirosa at the mountains of Poana, State of Tabasco. The older individual (Pl. XIV, fig. 8) is considerably worn; the other is perfect but not wholly adult, and neither contains the operculum. The species is allied, apparently, to the Cuban *Melania brevis* Orb., but is decidedly longer, and the liræ are much stronger.

The relationship of *Potamanax* to *Hemisinus* in sculpture and operculum is obvious, and has caused me to regard it as a subgenus rather than a distinct genus; but the total lack of a basal notch or truncation is a character usually considered of generic importance.

Explanation of Plate XIV.

Figs. 1, 2, 3, *Chrysodomus* (*Sipho*) *Stonei* Pils.
Fig. 4, *Eucalodium compactum* Pils.
Fig. 5, 6, *Pachychilus glaphyrus* var.
Fig. 7, *P. glaphyrus* var. *potamarchus* Pils.
Figs. 8, 9, *Potamanax Rovirosai* Pils.

NOVEMBER 1.

The President, GENERAL ISAAC J. WISTAR, in the chair.

Nine hundred and twenty persons present.

A paper entitled "Eclogæ Botanicæ, Part I," by Edw. L. Greene was presented for publication.

The following report, succeeded by a lantern exhibition of a collection of illustrative photographs with comments, was read by the author:—

REPORT OF THE OPERATIONS OF THE NORTH GREENLAND EXPEDITION OF 1891–1892.

To the Academy of Natural Sciences of Philadelphia:—

I beg to submit the following Report of the North Greenland Expedition of 1891–92.

The history of the inception and organization of the expedition is familiar to the Academy, and I need not revert to it here.

The incidents of the upward and return voyages are also in the Academy's possession through the reports of Professor Heilprin, the commander of the two auxiliary expeditions, and my report to the Academy from McCormick Bay, July 29th, 1891. I shall refer to these briefly to make this report cover from start to finish.

The "Kite" with the members of my own expedition: Dr. F. A. Cook and Messrs. Verhoeff, Gibson and Astrup, and my colored boy Henson, besides Mrs. Peary and myself; and Professor Heilprin's party: Drs. Sharp, Holt, Hughes, Burk and Keely, and Messrs. Ashhurst, Mengel and Kennealy, moved out of her Brooklyn dock at 5 P. M., Saturday, June 6th, 1891, and steamed up the East River amid the general salutes of the shipping. On the afternoon of the 11th, she entered Sydney, Cape Breton, to coal, and left again on the evening of the 12th for Godhavn, North Greenland, via the Strait of Belle Isle. After a vexatious delay of four days in the ice which was jammed in the Strait, the expedition arrived at Godhavn on the morning of the 27th. Remaining here until the afternoon of the 29th, to enable the members of the party to examine this interesting locality, the "Kite" started northward again. Upernavik was reached early in the morning of the 1st of July, and was left early in the afternoon of the same day.

The next morning found us at the Duck Islands, where a supply of ducks was laid in, and at night we got under way for the passage of Melville Bay. Up to this time no ice had been met since leaving the Strait. By midnight our further progress was arrested by the ice, and not until July 23rd did the "Kite" get free from it off Conical Rock.

In the meantime I had had the misfortune to have both bones of my right leg broken just above the ankle, by a blow from the iron tiller while the Kite was ramming her way through the ice. This accident occurred on the 11th of July, and from that time until July 27th (when I was carried ashore strapped to a plank), I lay upon my back in the cabin.

Early Saturday morning, July 25th, after futile efforts to force a passage through the ice which still stretched unbroken across Inglefield Gulf, the "Kite" swung around into McCormick Bay, on the north side of Omenak or Murchison Sound, and two boat parties were immediately sent out to reconnoitre the shores of the Bay for a house site. This was soon selected, and the work of erecting the house commenced at once. Fortunately, all the frames had been cut and fitted while we were fast in the Melville Bay ice, before the accident to my leg, and the remainder of the work was comparatively plain sailing.

Monday afternoon I was transferred to my tent on shore, close to the house where I could supervise the work. Two days later, on the 29th of July, all my supplies having been landed, I turned the "Kite" over to Professor Heilprin, and early the next morning (Thursday), she steamed south. During this time, the crew of the "Kite" and Professor Heilprin's party rendered my party much assistance in the work on the house. Saturday the roof was completed, and I was carried in, to escape a furious storm of wind and rain. Tidal and meteorological observations were commenced at once.

On the 12th of August, my house being completed as to the exterior, I sent Gibson, Dr. Cook, Verhoeff and Astrup in the "Faith," Gibson in command, with instructions to go to the great loomeries of Hakluyt Island, and obtain a supply of birds for our winter use; then to search the shores of Northumberland and Herbert for natives, and bring me back a hunter and his family. If no natives were found here, Gibson was to cross Whale Sound to the settlement of Nettiulume. In six days the party returned, Gibson

having successfully carried out all my instructions. The construction of a winter stone wall about the house was then commenced, the work on this being varied by seal, deer and walrus hunts, and reconnoissances of the neighboring ice caps by Astrup, on his ski.

Between September 7th and 30th two attempts were made, first by Astrup, Gibson and Verhoeff, then by Astrup and Gibson, to carry out my plan of establishing an autumn advance depot of supplies across Prudhoe Land at the southeast angle of the Humboldt glacier. In the last attempt, the men penetrated an estimated distance of thirty miles, when they were stopped by the condition of the snow. During their absence, I was moving about in the boat, most of the time gathering in deer. Matt, and my native hunter Ikwa, bagging fifteen. After the return of the men from the inland ice, a hunting party was kept almost continually in the field until the middle of November, when the score amounted to thirty-one.

The land had long since been shrouded with snow, and the Bay frozen over. The long winter night was now upon us, the sun having disappeared on the 26th of October; we settled down in comfort and security, with a well stocked larder, to pass lightly through it. Constant occupation, first in the little fittings about home, then in the construction of ski and sledges, varied by daily exercise, the visits of the natives, and the pleasant breaks of Thanksgiving and the Christmas holidays, congenial companionship and the best of food, carried us quickly through the somber darkness. Never was there a happier Arctic family than ours; the first sound to greet my ears from the boys' apartment in the morning was a laugh, and a laugh was the last thing I heard at night.

The return of the sun about the middle of February was marked by a storm of hurricane intensity. The thermometer rose to plus 41° F; rain fell in torrents, partially flooding Redcliffe, and even up on the ice cap, 2,600 feet above the sea level, where Dr. Cook, Astrup and myself had gone to greet the sun, rain fell for several hours. Early in March hunting parties were again sent out, and added ten more deer to our stock. Just after this, nearly all of my party and several of the natives then gathered about the house, were attacked by the grippe. April 18th, I started with Mrs. Peary, Gibson and my native driver for a round of calls among my Eskimo neighbors, and a tour of the unexplored recesses of Inglefield Gulf. From the settlement on Northumberland Island, Gibson returned to Redcliffe

with a load of dog food and several dogs which I had purchased; Mrs. Peary and myself went on.

The round of Inglefield Gulf was completed in six and a half days, during which time I discovered and named over thirty glaciers, at least ten of which are of the first magnitude. I doubt if any other known region shows glacial phenomena of such magnitude and variety as the shores of this body of water. On the last day of April, Dr. Cook, Gibson and Astrup, with five natives and eight dogs, started to the head of McCormick Bay, to get the inland ice supplies up the bluffs. May 3rd, I followed them with Matt and twelve dogs, leaving Verhoeff at Redcliffe to continue his meteorological and tidal observations, in which he had become intensely interested. Four days later, Matt returned to Redcliffe. A week of hardest work was consumed in transporting my supplies up hill and down hill, across the succession of great ice domes intervening between the shore and the edge of the true inland ice, fifteen miles distant.

On the 15th of May, the actual start may be said to have been made. My course was northeast true, which, assuming the charts to be correct, should enable me to clear the heads of the Humboldt, Petermann and Sherard Osborne indentations. Advancing on this course, much to my surprise, I found myself almost immediately on the divide, at an elevation of somewhat less than 5,000 feet, and gradually descending toward the Humboldt Glacier Basin. Hardly had I lost sight of the Whale Sound land before the distant peaks of the Rensselær Harbor coast rose into view.

After a gradual descent to an elevation of about 3,500 feet the surface of the ice became nearly constant as to elevation across the Humboldt Glacier plateau.

On the 24th of May, at a distance of 130 miles from McCormick Bay, all my boys having volunteered to accompany me, I selected Astrup as my companion for the long journey, and Gibson and Cook returned to Redcliffe. Two marches beyond this we began climbing again and on the last day of June had passed out of the Humboldt depression, and from the plateau southeast of Petermann, at an elevation of 4,200 feet, looked down upon the head of that Fjord and the great glacier discharging into it. Still ascending, we reached the summit at an elevation of 5,700 feet, June 5th, and then began descending into the St. George and Sherard Osborne depressions. Unfortunately, the next two marches were made in cloudy weather, and I got too deeply into the depression, and too near the center of

ice movement. As a result, about ten days were lost in getting out again, and back on to the crevasse-free level heights farther inland.

Again setting my course to the north and northeast everything went smoothly until the 26th of June. On this day I was discouraged to see the land, which had been occasionally visible in the northwest, rise into view to the north, and then northeast. Then the northwest entrance of a Fjord came into view, and we could trace its course southeasterly just beyond the nearer mountains of the land north and northeast. I changed my course to east, when I was soon confronted by the land and the Fjord beyond. Then I turned to the southeast, and travelled in that direction until the first of July. A wide break in the land beyond the Fjord opened out to the northeast, and I immediately headed for it. Land was reached just before midnight of the 1st. On the 4th of July Astrup and myself, having travelled some twenty-five miles over the coast land, came out upon a vertical cliff about 3,500 feet high, and saw below us the white expanse of the great bay into which the Fjord debouched. This bay opened out to the northeast, and its distant northern shore was free of snow and ice. In honor of the day, dear to all of us, I named this bay Independence. Just to the east of my observation spot, a huge glacier flowing due north discharged into the bay. At its narrowest part, where vertical cliffs squeeze it together, this glacier is ten to twelve miles wide, but the periphery of its fan-shaped face in the bay, is not less than twenty miles in extent. This glacier I have named the Academy Glacier.

July 7th, we were back at the edge of the inland ice, and on the 8th began our uneventful return journey. Bearing more to the south into the interior, in order to avoid the obstacles near the coast, in four marches we were on the great central plateau, cloud-capped and deep with snow. Here, at an average elevation of about 8,000 feet, we travelled for two weeks, then bearing to the westward, came down to the 5,000 feet level east of the Humboldt Glacier, and thence parallel to the outward route to the head of McCormick Bay. Just before midnight of August 5th, we met Professor Heilprin and his party, some ten miles from the edge of the ice, and early in the morning of Saturday the 6th, we touched the shore of McCormick Bay.

Monday, the "Kite" steamed down to Redcliffe. The next day I started up Whale Sound in one of my boats to get some tents and sledges which I had purchased of the natives. A continuance of

stormy weather detained me eight days on this trip, and when I returned I found that Verhoeff was missing. A vigorous and systematic search was at once instituted and prosecuted by the members of Professor Heilprin's and my own party, assisted by the crew of the "Kite," and all the able-bodied male natives at Redcliffe. The results of the search, the finding of minerals left by Verhoeff and his tracks leading to a great glacier where all further trace of him was lost, are already familiar to the Academy. August 24th, the "Kite" left McCormick Bay, and September 23rd the North Greenland Expedition had the pleasure of setting foot upon native soil again in Philadelphia.

The principal geographical results of the Expedition may be briefly summarized as follows:

The delineation of the unknown shores of Inglefield Gulf, and the imperfectly known shores of Whale Sound.

The delineation of the northern extension of the great Greenland inland ice cap, and the determination of the northern limit of the main Greenland land mass. The existence of detached ice-free land masses of less extent to the northward.

The rapid convergence of the Greenland shores above the 78th parallel.

The determination of the relief of an exceptionally large area of the inland ice.

The discovery of a large number of glaciers of the first magnitude.

Geological results go hand in hand with the geographical ones, and are comprised in the additions to our knowledge of the inland ice, and the large series of views showing the physical characteristics of the ice-free land, both in the north and about Whale Sound and Inglefield Gulf. These will, in due time, be placed in the hands of the Academy. All this material bears directly on the problem of the great ice age.

In the field of ethnology, the expedition has had exceptional opportunities and has obtained unique material. Dr. F. A. Cook, the ethnologist of the expedition, has obtained a complete census of the isolated little community of Smith's Sound Eskimos, with the relationships of every individual, and anthropometrical measurements of seventy-five individuals.

With Dr. Cook's assistance, I have y-
five, and shall obtain compl
rear elevations of between fifty

and all ages. I feel that this material will answer the interesting question, "Whence came these strange people?"

The mineralogical, botanical, and ornithological material is, perhaps, of not more than usual interest, though there are some rare specimens in the latter department, obtained by Mr. Gibson. Field notes, and lists of specimens in these branches, will be sent the Academy as soon as they can be put into shape.

The meteorological and tidal observations by Mr. Verhoeff are among the most complete and painstaking ever made in the Arctic regions. These will be put in the Academy's possession as soon as practicable. An independent set of four-hourly tidal and weather observations, kept by each officer of the watch, will prove of value in connection with the above.

While I have found no time, as yet, to digest and discuss with care my own observations of the inland ice, I feel justified in advancing even now, the following statements for the information of the Academy:

The inland ice of Greenland between the 78th and 82nd parallels is identical in all its characteristics with the inland ice under the 70th parallel east of Disco Bay.

The great glaciers of the northern and northwestern Fjords, of which the Academy Glacier is a magnificent example, have all the external features indicating resistless force and high velocity common to the glaciers of Disco Bay and Omenak Sound, as well as those of Inglefield Gulf.

Under normal conditions the wind of the great ice cap is always blowing from the interior outward and downward, perpendicular to the general trend of the coast.

In all discussions of those agencies which tend to balance the annual precipitation and prevent the rapid increase of the interior ice cap, the agency of the wind, ceaselessly hurrying the snow from the interior to the coast land-ribbon where it can melt, must be placed on a par with the agency of the glacier, in evaporation and sub-glacial liquefaction.

As regards methods and equipment, and their bearing upon future Arctic work, it may be claimed that the North Greenland Expedition has demonstrated that an itinerary upon the inland ice of Greenland may be laid out and carried into effect with nearly, it not quite, the same precision as the time-schedule of a freight train on any of our great railroads; and Professor Heilprin has shown that, with a

proper vessel, the dates from here to Whale Sound may be counted upon with as much certainty as those for any sea voyage of equal length. It has also been demonstrated that any portion of the Greenland coast can be commanded by two or three properly equipped men.

The report would be incomplete without an acknowledgment of my obligations to the members of my party: To Verhoeff, not only for his generous financial assistance to the enterprise, but for his absorbing interest and painstaking work in the field of meteorological and tidal observations entrusted to his care. To Gibson, strong and alert, quick with rifle and gun, the ornithologist and Nimrod of the party. To Dr. Cook, patient and skilful surgeon, indefatigable worker, earnest student of the peculiar people among whom we lived; he has obtained, I believe, a record of the tribe, unapproachable in ethnological archives. To Astrup, a young Hercules, fit descendant of the Vikings, almost a boy, yet with all a man's grit and endurance, his handsome face was never other than a pleasant sight to me, even under the most accentuated circumstances of monotony and fatigue. To Matt, my colored boy, a hard and faithful worker, and second only to Gibson in the trophies of the hunt. He deserves more credit, perhaps, than any other in joining the expedition, belonging, as he did, to a race supposed to be ill fitted for cold regions, and leaving behind him a young bride. To Professor Heilprin, and the members of the Relief Expedition, I am under obligation for many an act of courtesy, and many an hour of pleasant companionship.

Finally, I desire to thank the Academy most sincerely for the quick and efficient interest and assistance with which it honored my project less than two years ago, and for its jealous care for the safety of the expedition, resulting in the despatch of the "Kite" northward last summer, thus relieving my party of the last possible element of serious hardship. I assure the Academy that my personal gratification in having been enabled to carry out the plans of the expedition to the letter has been enhanced by the feeling that this good fortune is equally gratifying to my fellow members.

R. E. PEARY,
Civil Engineer, U. S. Navy.

NOVEMBER 8.

The President, GENERAL ISAAC J. WISTAR, in the chair.

Fifty-four persons present.

Papers under the following titles were presented for publication :—

"Contributions to the Life Histories of Plants, No. 8." By Thomas Meehan.

"Preliminary Outline of a New Classification of the Helices." By H. A. Pilsbry.

Note on the Geology of Mt. Desert Island.—DR. HENRY C. CHAPMAN exhibited remains of a Brachiopod, *Spirifer mucronota*, of an Ophiuran, *Ophiocten sericeum*, and *Yoldia glacialis* given by Charles S. Dorr, Esq., of Boston, to the Academy The specimens were obtained from clay in digging a well at "Old Farm," Bar Harbor, Mount Desert, Maine. Dr. Chapman stated that as far as he knew, with the exception of the remains of lowly organized forms of marine life found in the clay at Seal Harbor, these were the first fossils found at Mt. Desert. He referred incidentally to the discontinuity of the granite axis of the island, the intervals between the mountains being more or less filled up with water as seen at Jordan's Pond, Long Pond, Echo Lake, etc. Allusion was also made to the difficulty in determining the relative age of the flags, argillaceous shales and arenaceous schists deposited upon the flanks of the island, as at Bar Harbor, Schoonerhead and elsewhere. This is owing to the fact that in all such cases the deposits lie directly upon bed rock and are never superimposed on each other.

NOVEMBER 15.

Mr. LEWIS WOOLMAN in the chair.

Fifteen persons present.

Diffuse pigmentation of the epidermis of the oyster due to prolonged exposure to the light: regeneration of shell and loss of adductor muscle.—PROF. RYDER reported on behalf of Prof. R. C. Schiedt that oysters which had the right valve removed and exposed to the light in this condition, in a living state for a fortnight or so, developed pigment over the whole of the epidermis of the exposed right mantle and on the upper exposed sides of the gills, so that the whole animal from this cause assumed a dark-brown color. Animals so exposed not only attempted to reproduce the lost valve and hinge, but also partly succeeeded in so

doing, even reestablishing the insertion of the diminutive pedal muscle upon the inner face of the imperfectly reproduced right valve, which was deformed owing to the lack of support of the right mantle, because of the removal of the original right valve. As a consequence the right mantle was rolled up at the edge, and this deformation of the mantle was reflected in the attempted regeneration of the lost right valve. The pigment developed during exposure to light in the mantle and gills in oysters with the right valve removed which were kept alive in the aquaria at Sea Isle City by Prof. Schiedt was wholly confined to the epidermis as it normally is at the mantle border in the unmutilated animal in nature. The inference to be drawn from these facts is that the development of pigment in the mantle and gills was wholly and directly due to the abnormal and general stimulus of light over the exposed surface of the mantle and gills, due to removal of the right valve, and that the mantle border, the only pigmented portion of the animal, is pigmented because it is the only portion of the animal which is normally and constantly subjected to the stimulus of light.

Oysters which had the right valve removed were found to live perfectly well in the marine aquaria at Sea Isle, and would no doubt have survived till now had Prof. Schiedt been able to continue his experiments there. The most remarkable results obtained as a consequence of these experiments were that the adductor muscle was soon attacked by bacteria and destroyed by putrefaction while the great ganglion underlying it remained uninjured. The pericardiac cavity was also torn open, exposing the heart completely, in some instances. In these cases the heart continued to beat and propel the blood through the other organs of the body as if nothing untoward had happened. The maximum rate of pulsation of the heart noted was 52 per minute, which is much greater than the rate hitherto reported.

The anus was also retracted into a new and more anterior position, owing to the loss of support which it had suffered in consequence of the sloughing away of the adductor muscle. Whether the adductor muscle thus sloughed away would ultimately be reproduced was not determined, since the experiments were interrupted before the animals had time to present evidence of such regeneration of the lost muscles.

These experiments open up a most suggestive line of investigation upon other univalve and bivalve mollusca, viz: experimental researches as to the effect of removing the valves and exposing them to the light. Many other species, both marine and freshwater, might obviously be experimented upon with very instructive results as respects the questions raised by the present communication.

The hermaphroditism and viviparity of the oysters of the Northwest coast of the United States.—PROF. J. A. RYDER also reported on

behalf of Prof. R. C. Schiedt, of Franklin and Marshall College, Lancaster, Pa., the latter's discovery of the fact that the oysters native to the northwest coast of the United States are hermaphrodite and viviparous. Specimens from the coast of Oregon and Washington show that the same condition exists in the reproductive follicles as in those of *Ostrea edulis* of Europe. The presence of eggs and of spermatoblasts and spermatozoa in the same follicles is the invariable rule. The ova, like those of *O. edulis*, are much larger than those of *O. virginica*, though perhaps not quite so large as the former. The embryos are fertilized in the gill and mantle cavities, where they undergo development.

These northwest-coast oysters also resemble the oysters of Europe in that they are small and have little or no indication of purple pigment on the impression or point of insertion of the adductor muscle, which is so conspicuous a feature in *Ostrea virginica* of our eastern coast.

On the cause of the greening of the oyster and its presumed algous endoparasites.—PROF. JOHN A. RYDER also reported on behalf of Prof. Schiedt and himself the fact that living oysters from which the right valves had been removed, also became green about the heart as soon as green algæ appeared on the sides of the aquaria in which the oysters were kept at Sea Isle laboratory. Our experience, unlike that of Prof. Decaisne and others in France, was not conclusive as to the cause being the bluish green pigment, *phycocyanin*, absorbed from certain diatoms. On the contrary, the forms of algæ present were diatoms, desmids and the spores of *Ulva*, and, possibly, round-celled unicellular forms, so that it became impossible to decide from which species, used as food, the pigment was derived that discolored the affected heart of the specimen observed to become tinged.

Prof. Schiedt now informs the speaker that some of these marine algæ which are believed to have caused the discoloration of the oysters at Sea Isle, he has kept alive in a small aquarium filled with sea water, at Lancaster, for over two months since he left the sea-side laboratory.

The occurrence of these unicellular algæ of various kinds in association with the abrupt appearance of the green color in some one organ of the oyster, as happened at Sea Isle City, opens up the query whether the singular brownish green bodies so often observed by Prof. Ryder in sections of the connective tissues of the oyster are not endoparasitic algæ, which are in some way genetically connected with some of the forms that appeared in association with "greened" oysters at Sea Isle. The late Prof. Leidy's discovery, many years ago, of algæ in the tissues of fresh-water mussels, is suggestive in this connection.

NOVEMBER 22.

REV. HENRY C. MCCOOK, D. D., Vice-President, in the chair.

Fifty persons present.

A paper entitled "The Evolution of the Premolar Teeth in the Mammals." By W. B. Scott, was presented for publication.

A Meteoric Stone seen to fall at Bath, South Dakota.—DR. A. E. FOOTE said he wished to put on record the reception of a meteoric stone which was seen to fall on the 29th day of August, 1892, two miles south of the town of Bath, South Dakota. About four o'clock in the afternoon Mr. Lawrence Freeman and his son were working in the field when they were alarmed by loud reports, and looking up, saw the meteoric stone fly through the air and fall about twenty rods from where they were. It seemed to be followed by a cloud of dust or vapor. The stone had penetrated the hardened prairie to the depth of sixteen inches and was at once dug up, and was found to be so warm that it was necessary to wear gloves to handle it. The weight of the meteorite is 46¾ pounds. It was probably originally about one pound heavier but lost three fragments just before reaching the earth. Internally and externally it much resembles the stones from Winnebago County, Iowa, both the chrysolite and the iron being disseminated through the mass in fine grains. Preliminary tests by Mr. A. P. Brown, of the University of Pennsylvania, showed the presence of both nickel and cobalt in the iron. It is a somewhat remarkable fact, that although this region is sparsely settled, the number of observed falls for a period of several years has been extraordinarily great in proportion to the whole number of falls observed during the same period. The noise of the explosion was so great that it was heard, not only in the town of Bath, but in Aberdeen, a town much more distant, and was described in the Aberdeen paper as resembling distant cannonading. The annexed affidavit contains the statement of an eye witness.

Affidavit of Charles Freeman, Bath, South Dakota, November 18, 1892.

"Be it known that on this 18th day of November, 1892, personally appeared before me, Henry T. Root, a Notary Public for South Dakota, Charles Freeman, of the town of Bath, Brown County, South Dakota, who deposes and says, that on the 29th day of August, 1892, while at work on his father's farm, on Section 32 of the town of Bath, he saw a meteoric stone fall near where his father, brother and himself were working and that they then proceeded to dig up the aforesaid meteoric stone and did bring it in the evening of the same day to the store of J. D. Mason, in the town of Bath, where it has since remained, and that he has this day boxed and

shipped the aforesaid stone to Dr. A. E. Foote, of No. 4116 Elm Avenue, Philadelphia, Pennsylvania.

Signed, CHARLES FREEMAN."

This interesting specimen will remain permanently in Philadelphia.

NOVEMBER 29.

The President, GENERAL ISAAC J. WISTAR, in the chair.

Sixty-four persons present.

The Committee on the HAYDEN MEMORIAL GEOLOGICAL AWARD reported that the medal and the interest arising from the fund had been this year voted to EDUARD SUESS of Vienna.

REPORT OF THE COMMITTEE ON THE HAYDEN MEMORIAL GEOLOGICAL AWARD.

The Committee appointed by the Academy of Natural Sciences of Philadelphia to recommend the award of the Hayden Memorial Medal and accompanying fund, for the year 1892, have the honor to report to the Academy that they have selected PROF. EDUARD SUESS of Vienna, as their choice for the distinction which the award confers.

PROF. EDUARD SUESS was born in London, Aug. 20th, 1831, and is, therefore, but little beyond the prime of life. He studied in Prague and in Vienna, becoming in 1852 assistant in the Hofmineralienkabinett of Vienna, professor of geology in 1857, and shortly afterward general adviser to the Water Commission. Under his guidance the present splendid system of water supply, from a natural reservoir located in the Raxalp, was introduced into the Austrian capital. From 1863 to 1873 Prof. Suess was a member of the Common Council of Vienna; in 1869 he was elected a member of the Lower Austrian Diet, and in 1873 a representative to the Imperial Reichsrath where he distinguished himself as a brilliant orator and leader of the "Left."

For upward of forty years Prof. Suess has been an indefatigable worker in the domain of geology and paleontology, and it can be

justly said of him that there is scarcely a paper prepared by his pen during this period which does not possess more than ordinary merit. To a mind richly stored with facts is added a perceptive and reasoning faculty which is as broad and far-reaching as it is brilliant, and from which have emanated many of the more luminous conceptions which inseparably belong to the "new geology." The Suess-Neumayr theory of mountain construction, which recognizes a one-sided thrust as the dominant motor of orographic flexures—a view, however, that has not yet been accepted by all geologists—is principally the creation of his mind; to him, likewise, must be credited the conception, or at least the elaboration of the hypothesis, that the earth is undergoing a process of continuous sectioning (*Verstückelung*), i. e., of having its superficial parts dropping in blocks toward the planetary center. Prof. Suess is a firm non-believer in secular movements of elevation and depression of the continental areas, and an equally firm upholder of the doctrine of oceanic instability, recognizing that the relative changes in the position or levels of the land and water are due primarily to differential movements of the oceanic surface. This conception, which has only recently been entertained by English and American geologists, has long since served as a starting point with many of the foremost geologists of the continent of Europe.

Among Prof. Suess' numerous papers may be mentioned "Böhmische Graptolithen" (1852); "Der Boden der Stadt Wien" (1862); "Ueber den Lösz" (1866); "Charakter der Östreichischen Tertiärablagerungen" (1866); "Bau der Italienischen Halbinsel" (1874); "Die Entstehung der Alpen" (1875); "Die Zukunft des Goldes" (1877). Prof. Suess' most extensive work is the "Antlitz der Erde," of which two volumes have thus far appeared (1885–1888). This work shows the impress of the master on almost every page, and for breadth of scholarship can find a fitting place only between the "Cosmos" of Humboldt and the "Origin of Species" of Darwin.

ANGELO HEILPRIN, Chairman.
PERSIFOR FRAZER,
J. P. LESLEY,
WM. B. SCOTT,
BENJ. SMITH LYMAN,
Committee.

The following were elected members —

Charles Coulter, William De Cou, Henry C. Ford, William E. Meehan, William A. Shryock, Edw. S. Scranton, Jos. G. Harrison, Edw. Coles, Wm. Wynne Wister, Jr., Mary Pearsall, Anna W. Pearsall and Ellen W. Longstreth.

C. Lloyd Morgan of Bristol, England, and John Baird of Manchester, England, were elected Correspondents.

The following were ordered to be printed:—

ECLOGÆ BOTANICÆ, NO. 1.

BY EDWARD L. GREENE.

1. New or Noteworthy Thistles.

Eighteen years have now elapsed since Professor Asa Gray published his "Synopsis of North American Thistles."[1] In that paper about thirty species were enumerated, six of which were described as new; and four of these six were Californian. But the vast field of Californian botany had been only very imperfectly explored at that time; and thistles are plants which collectors, for obvious reasons, neglect. During the lapse of these eighteen years, however, more than a half-dozen new thistles have been recognized in California. Two of them have already been published by the present writer; and the diagnoses of the rest are now to be given.

Dr. Gray, in following Bentham and Hooker as to the proper name for the genus, seems not to have acted wisely; for the *Cnicus* of the ancient Fathers of Botany is *Carthamus tinctorius*, while the *Cnicus* of Linnæus has for its type species what is now commonly known as *Centaurea benedicta;* so that whether the initial date for genera be 1753 or 1700, *Cnicus* is not free for application to this vast genus known to us as Thistles, the Latin name of which must be either *Carduus* or *Cirsium*. These two will be retained, or else the latter genus will be merged in the former, according as the genera be considered distinct or inseparable. I regard them as inseparable, and therefore employ that name which has the sanction of Linnæan usage, and has been adopted by M. Baillon.

Carduus crassicaulis.

Very stout and tall, 4 to 7 feet high: stem an inch in diameter below, strongly striate throughout, simple up to near the summit, there becoming somewhat thyrsoid-paniculate, with 3 to 7 short-peduncled heads, 1½ to 2 inches high: herbage permanently hoary-lanate: leaves small, pinnately parted, the segments spinose-tipped and the whole margin spinulose-ciliate: involucral bracts rather lax, linear-lanceolate to lanceolate-acuminate, all tipped with a slender straight spine, the outer and middle ones with pectinate-spinescent

[1] Proceedings of the American Academy of Arts and Sciences, Vol. X, pp. 39–48, 1874.

margins: segments of the whitish or pinkish corolla about as long as the throat.

Abundant in low, grassy, and occasionally inundated river bottoms of the lower San Joaquin, near Lathrop, California. A very well marked and probably rather local species, flowering in May.

Carduus callilepis.

Stem and leaves unknown: head pedunculate, depressed-globose, barely an inch high: bracts of the involucre in many series and closely imbricated, the outer broadly obovate, all except the innermost exposing round-ovoid tips with deeply lacerate scarious or semi-cartilaginous margins and an abrupt short rigid erect terminal spine; the very innermost with lanceolate scarious-margined and fimbrillate tips: flowers small, ochroleucous, the limb of the corolla only a third as long as the throat.

Western California; probably Humboldt Co., the material very scanty, but indicating a very pronounced and remarkable species, with involucre more like that of a *Centaurea* than of any other known *Carduus*.

Carduus hydrophilus.

Rather slender and freely branching, 4 or 5 feet high; herbage when young, pale with a fine and close arachnoid tomentum, in maturity green and glabrate: leaves deeply pinnatifid into uniform 3-lobed segments: heads numerous, little more than an inch high, glomerate in twos and threes at the ends of the numerous and paniculate widely spreading branchlets: involucre ovate, the somewhat appressed-imbricate scales pluriserial, rather firm, with a green and glutinous ridge toward the summit, and ending in a short, slender, erect or slightly spreading spine: corollas deep rose-purple, the limb about equalling the throat: pappus bristles very delicately and sparsely long-plumose below, naked at the aristiform or clavellate tips.

Very common in the brackish marshes of Suisun Bay, California, where it grows within reach of tide water, and is associated with the equally local *Cicuta Bolanderi*, and flowers in July.

Carduus occidentalis Nutt. Trans. Am. Phil. Soc. vii, 418.

Very stout, 1 to 3 feet high; the lanceolate pinnatifid leaves densely white-tomentose beneath, only hoary-lanate or arachnoid above; heads 2 inches high, or larger, on long and stout peduncles; bracts of the involucre in very many series, all linear-subulate, ascend-

ing, spinose-tipped (the spine straight), all connected by a more or less heavy indument of arachnoid, very fine hairs; flowers deep red; segments of the corolla little surpassing the throat; pappus short, the very slender plumes naked at tip, and scarcely dilated.

Abundant on sand dunes near the sea, in western California, at San Francisco, and southward to Santa Barbara and the outlying islands. A remarkable and maritime species with which the next has needlessly been confused.

Carduus candidissimus.

Stout, erect, 2 or 3 feet high, densely and permanently white arachnoid-tomentose throughout; leaf-outline as in the last; heads few, on shorter and stouter peduncles, 2 inches high, but narrower than in the last; outer bracts of the involucre with dilated and closely appressed base and squarrose rigid linear-acerose spinescent tip, all densely arachnoid-tomentose; flowers crimson; pappus an inch long, plumose almost throughout.

Common on dry hills in extreme northern California, thence southward, but in the interior only, though coming out to the seaboard at Santa Barbara. Readily distinguished from *C. occidentalis* by its dense white tomentum and very different involucre and pappus.

Carduus venustus.

Stoutish, 3 feet high, sparingly branching; lower leaves unknown; cauline few and reduced, permanently more or less arachnoid, white beneath; heads large, 2 inches high and broad, terminating long pedunculiform branches; involucre glabrate, the very numerous bracts with closely appressed base and long, squamose, rigid, green lanceolate subulate and rather abruptly short-spinescent tips; corollas bright crimson, the segments longer than the throat; pappus-plumes barbellate above the plumose part, the tips scarcely dilated.

This belongs to the hills of the inner Coast Range of California, from Vacaville southward. It is our most beautiful thistle, and appears to have been made a part of the aggregate *Cnicus occidentalis* in the Synoptical Flora of Gray, though it is more strictly an ally of *C. Californicus* (which is the *C. lilacinus* Greene, Bull. Calif. Acad. ii, 404 = *Carduus Californicus*).

Carduus undulatus Nutt., Gen. ii, 130.

This very widely disseminated thistle of western North America, is either excessively variable, or else an aggregate embracing many species. The original station for it, as a specific type, is "calcareous

islands in Lake Huron," and botanists of the middle sections of the Union would do well to collect again the type. Its real characters cannot be made out from Nuttall's diagnosis, except as compared with eastern species. Gray's description does not pretend to define the plant of any one locality, but is made loose enough to cover that vast aggregate of specimens which he had from all parts of the country between the Great Lakes and the Pacific, and from Manitoba to Mexico. Such a collection exhibits forms very distinct in general appearance, and enough of them to make five or six fair geographical species without much character of flower or fruit, though with good habitual marks, and some vegetative characters. The Lake Huron type was low and "few flowered," and had bifid, spiny, overlapping lobes to its leaves, which were tomentose on both sides; a large subglobose involucre, with appressed lanceolate acuminate bracts, the spinescent tips of which are presumably spreading or reflexed. The heads, in all the western representatives of the aggregate, are ovate rather than subglobose, and have the spinescent tips of the scales as above described. The pappus of the marginal flowers is only barbellate, while in all the rest in the head it is plumose; but this it has in common with many other American species. Some of our most striking western plants of this aggregate may be recognized under *C. undulatus*, as follows:

Var. **Douglasii.** *Cirsium Douglasii* D. C., Prodr. vi, 643 (1837).

Stout, probably not tall; heads rather numerous, not large, short-pedunculate; leaves white beneath, and nearly so above, with a close arachnoid tomentum, deeply pinnatifid, amplexicaul; heads about 1 inch high, the ovate and ovate-lanceolate bracts closely appressed, with a glutinous spot below the short-spinescent tip; segments of the corolla shorter than the throat. From Oregon to middle California, in the wooded regions of the coast Range, on rather open ground, hillsides, etc. This is presumably the type of *C. Douglasii* and very possibly of specific rank.

Var. **megacephalus** (Gray, as *Cnicus*).

This has few and quite large heads, and a very ample thin foliage not strongly spinescent. It appears to be a tall plant, and is from the interior of Washington and northern Idaho. Mr. Leiberg's n. 654 is doubtless a good type of this. It is also possible that this rather than the preceding may be the true *Douglasii*.

Var. **Nevadensis.**

Of middle height, but widely and paniculately branching, the small heads solitary or glomerate at the ends of the branches; leaves green and glabrate above, hoary-arachnoid beneath, the lobes rigidly spiny; bracts of involucre closely appressed except the slender-spinose tips. At the eastern base of the Sierra Nevada, California, near Truckee, etc., collected by the writer in 1883.

Carduus Mohavensis.

Stoutish, branching, 3 to 5 feet high, whitish throughout, with a minute and close tomentum; leaves of lanceolate outline, narrow and with lobes not overlapping, bearing few and rigid spines, the middle cauline decurrent on the stem for one-third their length, and all except the very lowest manifestly decurrent; heads few and terminal, small, round-ovate; ovate involucral bracts somewhat arachnoid, tipped with spreading spine of their own length or longer; segments of the reddish corolla as long as the throat; anther tips attenuate-subulate; pappus of marginal achenes merely scabrous, of the others only sparsely plumose and that near the base.

At Rabbit Springs, in the Mohave Desert, 1886, S. B. Parish, n. 1,834; distributed as *C. undulatus*, from which its conspicuously decurrent foliage and different pappus at once distinguish it.

Carduus Rusbyi.

Probably very tall, rather slender, paniculate above, with many small ovate heads; radical leaves long-petioled, 1 to 2 feet long, 4 inches wide, sinuate-pinnatifid, only sparingly and rather softly spinescent, pale beneath with a thin tomentum, glabrate above, in texture quite thin; floral leaves very small, each lobe and tooth bearing a stout long spine; ovate bracts of involucre appressed, coriaceous, tipped with a long stout spreading spine; flower apparently whitish; segments of the corolla little surpassing the throat; anther-tips attenuate; outer achenes with scarcely barbellate bristles.

Southern Arizona, 1883, Dr. H. H. Rusby. Species remarkable for the strong contrast between the soft and scarcely armed lower leaves and the excessively spinose floral ones.

Carduus Bernardinus.

Rather slender, leafy below, bearing at summit 1 to 3 long peduncled subglobose heads; leaves of linear or lanceolate outline, sinuate-toothed or lobed, and with few small spines, equally white-

tomentose above and beneath; heads an inch high and nearly as broad; ovate-acuminate, weakly spinescent involucral bracts rather closely appressed, their margins distinctly ciliolate; reddish corollas with remarkably wide cylindrical throat and similarly wide linear and cuspidate segments of about equal length; anther-tips with an abrupt long mucro; pappus bright-white, that of the marginal achenes barbellate, of the others strongly plumose.

At an altitude of 4,500 feet in Little Bear Valley, of the San Bernardino Mountains, southern California, S. B. Parish, 1884, n. 1,686. This was distributed as *C. Californicus;* but the flowers cannot have been examined by Dr. Gray; or scarcely the involucral bracts. It is a most excellent species.

The following species of the western United States and Mexico are in my herbarium, without a nomenclature, under *Carduus,* and I here transfer them.

C. Americanus. *Cnicus Americanus* Gray, Syn. Fl. 398.

Colorado to California.

C. Parryi. *Cnicus Parryi* Gray, Proc. Am. Acad. x, 47.

Colorado to Utah.

C. scopulorum. *Cirsium eriocephalum* Gray, Proc. Acad. Philad. 1863, p. 69, and *Cnicus eriocephalus* Gray, Proc. Am. Acad., l. c.

Colorado to Montana.

C. edulis. *Cirsium edulis* Nutt., Trans. Am. Phil. Soc. vii, 420. *Cnicus edulis* Gray, l. c.

Oregon and California.

C. Neo-Mexicanus. *Cirsium Neo-Mexicanum* Gray, Pl. Wright, ii, 101, and Proc. Am. Acad. x, 10, under *Cnicus.*

New Mexico.

C. Andersonii. *Cnicus Andersonii* Gray, Proc. Am. Acad. x, 44.

Sierra Nevada of California.

C. Arizonicus. *Cnicus Arizonicus* Gray, l. c.

Arizona.

C. Rothrockii. *Cnicus Rothrockii* Gray, Proc. Am. Acad. xvii, 220.

Arizona.

C. quercetorum. *Cnicus quercetorum* Gray, Proc. Am. Acad. x. 40.

Coast Range hills, in Western California.

C. fontinalis. *Cnicus fontinalis* Greene, Bull. Calif. Acad. ii, 151.

Crystal Springs, San Mateo County, California.

C. amplifolius. *Cnicus amplifolius* Greene, Pittonia, i, 70.

Coast Range, California.

C. Grahami. *Cirsium Grahami* Gray, Pl. Wright, ii, 102, and Proc. Am. Acad. x, 42, under *Cnicus*.

Arizona.

C. ochrocentrus. *Cirsium ochrocentrum* Gray, Pl. Fendl. 110, and Proc. Am. Acad. xix, 57, under *Cnicus*.

Southern California to western Texas, and Colorado.

C. Breweri. *Cnicus Breweri* Gray, Proc. Am. Acad. x, 43.

California and Oregon.

C. raphilepis. *Cnicus raphilepis* Hemsl., Biol. Centr. Am. Bot. ii, 252.

Southern Mexico.

C. acantholepis. *Cnicus acantholepis* Hemsl., l. c., 251.

Mexico.

C. Mexicanus. *Cirsium Mexicanum* D. C., Prodr. vi, 636. *Cnicus Mexicanus*, Hemsl., l. c.

Southern Mexico.

C. heterolepis.

Stout and tall (8 feet high), parted above into long pedunculate and monocephalous branches; leaves a foot long, sessile or short-petioled, pinnately parted into lanceolate spinose segments, strigose-pubescent above, white-tomentose beneath; heads 2½ inches high; bracts of involucre very unequal, loosely imbricate, the exterior and middle ones lanceolate and lanceolate-acuminate, pectinate-spinulose and with straight spinose tip; the inner 2 inches long, linear, thin and almost scarious throughout; segments of the corolla about equalling the throat; all the pappus-bristles plumose.

State of Jalisco, Mexico, 1889, C. G. Pringle, n. 2,435; distributed as a *Cnicus*, with the specific name here continued; but I cannot find that any description was published.

C. linearifolius. *Cnicus linearifolius* S. Wats., Proc. Am. Acad. xxvi, 143.

Southern Mexico.

C. velatus. *Cnicus velatus* S. Wats., l. c.

Southern Mexico.

C. Pringlei. *Cnicus Pringlei* S. Wats., l. c., xxv, 156.

State of Nuevo Leon, Mexico.

C. excelsior. *Cnicus excelsior* Rob., Proc. Am. Acad. xxvii, 179.

Slender and perhaps very tall; lower leaves unknown; cauline oblong-lanceolate, scarcely either lobed or toothed, but more or less distinctly spinose-serrulate, decurrent along the stem for at least a third their length, white-tomentose beneath, hoary above; heads small, clustered at the ends of slender paniculate branches; bracts of involucre regularly and closely imbricated, ovate, viscid on the back below the slender spreading terminal spine; corolla rose-purple, the segments quite surpassing the anthers and style, but much shorter than the tube; pappus sordid, altogether plumose.

C. Potosinus.

Near the last, but stouter and perhaps taller; cauline leaves ampler, deeply pinnatifid, with sharply spinose lobes, not in the least decurrent; flowers and fruit as in the last.

This species and the one preceding are in Mr. Pringle's Mexican collection of 1891, from the State of San Luis Potosi, and are distributed in one sheet, under the number 3,768. The printed ticket bears the statement that the plants grow in low lands, and attain a height of from six to ten feet. In *C. excelsior* the leaves appear as if joined to the stem for a third their length without any tapering from the point of junction; a character so remarkable that the two plants can in no wise be treated as one species.

2. Three New Perennial Lupines.

Lupinus floribundus.

Stems tufted, rather firmly erect (sometimes decumbent at base), a foot high or more, with several ascending branches, each ending in a well developed raceme; herbage more or less villous or hirsute; leaves all short-petioled; leaflets about 7, an inch long or less, oblong-lanceolate, acutish; racemes very short-peduncled, dense and cylindrical, 2 to 4 inches long, scarcely ¾ inch in diameter, the flowers very small, light blue; abruptly falcate-incurved keel about equalling the wings and only 2 or 3 lines long, the banner shorter; ovary densely hirsute.

A well marked and exceeding pretty lupine of the region of the middle and upper Bear Creek, in the mountains of Colorado directly west of Denver, growing in open woods among pines (*P. ponderosa*); collected by the writer in 1873, 1875, and again in

1889, and until recently supposed to be the *L. parviflorus* Nutt., to which, however, it can hardly be very closely related.

Lupinus gracilentus.

Stems tufted, erect, slender, leafy, 2 feet high; herbage green and not conspicuously pubescent (scantily pilose or villous under a lens); lowest leaves on slender peduncles, 6 or 8 inches long, and with narrow, adnate, long-setaceous-pointed stipules; leaflets about 7, linear-falcate, acute, 2 inches long, more or less; racemes terminal only, and on long, slender, naked peduncles; flowers in 4 to 6 distinct verticils; calyx-tube slightly gibbous at base; corolla rather small (4 or 5 lines long), blue; keel strongly falcate-acuminate, naked, slightly surpassing the wings, these longer than the banner; ovary hirsute; immature pods appressed-villous.

In the Tuolumme Cañon of the Sierra Nevada, California, 1889, Messrs Chesnut and Drew.

Lupinus Covillei.

Erect, stoutish, 2 or 3 feet high, the striate stems leafy up to the subsessile, long raceme; herbage rather light green, soft to the touch, with a hirsute pubescence; petioles about equalling the leaflets, these about 9, linear-lanceolate, 1½ to 2½ inches long; racemes elongated, the flowers in distinct verticils; bracts fully equalling the flowers, linear-filiform, somewhat persistent; calyx and pedicels densely hirsute (as also the young pods); corolla purple, ½ inch long, the banner slightly shorter than the wings; keel not strongly falcate, naked, or with a few hirsute hairs below the tip.

Near Farwell Gap, in the Sierra Nevada of California, at an altitude of 10,000 feet, August 30, 1891, Messrs. Coville and Funston, n. 1,746. The species is also in the State Survey collection, from the same region, and was evidently mistaken for the far northern and very different *L. lepidus*.

CONTRIBUTIONS TO THE LIFE HISTORIES OF PLANTS, NO. 8.

BY THOMAS MEEHAN.

EUPHRASIA OFFICINALIS.

Mr. Darwin, in his interesting work on "Cross and Self-fertilization of Flowers" (1877), places this pretty little plant in the list of those which have "become modified so as to insure self-fertilization." Some additional information on the subject makes it worth while to go over the whole matter again.

The flowers are so abundantly fertile that one would at once infer that it is self-fertilized, but the apparently strong proterogynous character of the flower leads to a suspicion that this impression is wrong. The curved style is projected beyond the corolla before the latter is fully expanded, appearing like a folded thread of silk, completely closing the mouth. The stigma at the end of the incurved portion is bent down onto or under the anthers which present it with pollen before the flower has fully expanded. So early is the flower fertilized that the pistil, having fulfilled its function, dies away almost immediately after the mouth of the corolla fully expands. The flower presents the remarkable phenomenon of a pistil dried up almost as soon as the corolla is fully open. It seems evident that the pistil matures long before the stamens, but the curvature of the style keeps the stigma in contact with the stamens so that it cannot escape fertilization. If the pistil were projected in a straight line, as is usual in flowers, it is more than likely that aid would be required in securing pollination. It does look as if the expression quoted from Darwin, that the flower had been modified to ensure self-fertilization, is in this instance literally correct.

NOTES ON GAURA AND ŒNOTHERA.

Although in a general way, flowers of some species of *Gaura* and allied genera are known to open toward evening, and with some suddenness, so far as I know, no details of the phenomenon have been recorded. Having plants of *Gaura biennis* and of *G. parviflora* within a hundred feet of each other, under nearly the same conditions, I spent a week previous to the 20th of August in closely watching them, with the view of noting any difference in the behavior of the two closely allied species.

Having come to look on those plants that are abundantly fruitful as self-fertilizers, I was at first struck with the exceptional fruit-

fulness of every flower in *Gaura parviflora*. On one spike examined, 148 flowers had bloomed, and each had produced a perfect capsule. Many more flowerbuds had yet to open. The result of the observations showed that the plant is absolutely a self-fertilizer. On every night of my observations the first blossoms commenced to open at 7.15 o'clock, and by 7.30 all had opened that would open on that evening. The expansion is so extremely sudden that it is only with great difficulty that the process can be observed. The eye can be taken for an instant from one flower to another alongside, and instantly back again, only to find that expansion has occurred. A good magnifier is necessary to see the process distinctly. On expansion the petals stop when at a right angle with the axis, but the sepals fly completely back on a line with the ovarium. Opening some flowers at 7 o'clock, no pollen is visible, but the anther cells are ruptured and abundantly pollen-covered at expansion. We may conclude that this act is simultaneous with the opening. The anthers are held to the stigma by the gelatinous pollen, except an occasional one that is held fast by the expanding petal or sepal, and drawn over, which also shows that the anther cells rupture at the time of expansion or a little before. As evening progresses the stamens draw their anthers more or less away from the stigmas, but they alone can fertilize the pistils. By a lamp, later in the evening, small night moths are found about the flowers, and some moth hairs on many of the glutinous stigmas show that the flowers have been visited by them. The flowers commence to fade at daylight, the stamens dropping first, then the pistil, and by 8 A. M. the petals wither, unless the day be cloudy, when they continue a little longer. The upper portion of the leaves of this species are vertical, the result apparently of a continuation of the coiling tendency longer than in some other plants, and without any physiological significance.

Gaura biennis.—In this species some open at 8 P. M.; all are open at 8.30 P. M., that are to expand that evening. They open by jerks. First there is a sudden flying apart of the sepals, just enough to show the pinkish-white petals, the openings being not more than two lines in width. After about three minutes another effort occurs, when both the sepals and petals are at right angles with the axis. After another rest of about three minutes the sepals fall back on the ovarium. An effort was made to encourage a flower to open earlier in the e[illegible] the sepals

with a pen-knife, but it had no effect on the opening of the flower till the regular opening time arrived. The stamens are shorter than the style, so that at expansion the anthers are below the stigma. The pistil remains erect, and the stamens fall without the pollen coming in contact with the stigma, as far as I could trace. The pistils droop by morning, when the under surface of the compound stigma is usually found covered with pollen, as if it had dropped from the anthers. A large number of species of night moths attend the flowers during the night, and most of the flowers have moth hair on the stigmas. It seemed probable that insect aid had much to do with pollinating the flowers.

The lower portions of the spikes are infertile, and this adds suspicion that insects are necessary to aid in the work of fertilization, as they may not have been present or found the Gaura plants till many flowers had fallen, but nearly all the later flowers are fertile. Soon after daylight the stamens and style have withered, but the petals do not collapse till 8 or 9 o'clock, and if the day be cloudy, the petals will continue apparently fresh till noon.

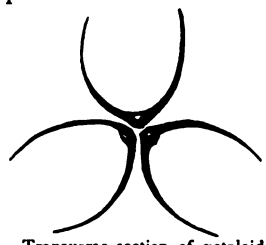
Aside from fixing the exact time and manner of the opening of the flowers of these two species, there is a peculiar interest in the fact that while the one is undoubtedly a strict self-fertilizer, its near neighbor seems to be in a great measure dependent on insect agency, and this remarkable difference is apparently due merely to the fact that, in comparison with the pistil, the stamens are a little longer in the one species than in the other.

Œnothera biennis.—I endeavored to ascertain the exact time and manner of the opening of the flowers of *Œnothera biennis*, but could not manage to catch it at the right moment. An interesting fact well worth recording, however, is that the anther cells burst when the bud is comparatively young, long before expansion, covering the stigma with the flower's own gelatinous pollen. The stigma is not receptive at this time, but the pollen remains until it is, thus insuring self-fertilization.

The Carpellary Structure of Nymphæa.

An abnormal flower of *Nymphæa odorata* from New Jersey, sent to me by Mrs. Edward S. Sayres, of Philadelphia, indicates the manner in which the carpels are formed. The place of the usual radiating stigmas was occupied by three petaloid processes, very suggestive of the

pistils of an Iris. These were recurved as in the annexed diagram, which shows a cross section of the three. From this it would appear that the ovarium is made up of a number of carpellary leaves of which the midribs form the axis. In the normal flower the compound ovary is usually from 12- to 24-celled, according to Gray's Genera; in this case but three carpels were attempted. In this genus the line between the various floral organs is very finely drawn. Petals, stamens, and the carpellary system with its pistils run closely into each other. Hence the numbers in each class of organs easily vary. It would not be wholly unexpected to meet with cases in this or allied genera where the flowers would have the pistils wholly aborted; that is, the plants might produce wholly staminate flowers.



Transverse section of petaloid carpels, replacing the normal gynœcium in *Nymphæa odorata*.

On the Sexual Characters of Rhus.

Exact botany suffers much from the want of care in the application of terms, especially illustrated in the use of the words hermaphrodite, dicœcious, polygamous, and polygamo-dicœcious, by different authors in connection with the genus *Rhus*. There is a section described as hermaphrodite, in which the mist tree of gardens, *Rhus cotinoides*, is placed. But I have shown that this species is truly dicœcious.[1] Chapman, in his "Flora of the Southern United States," divides the North American species into two sections, one "Flowers polygamous," the other "Flowers dicœcious." He places *Rhus copallina* in the former section, leaving the dicœcious section to the poison Rhus, *R. venenata*, and *R. Toxicodendron*. Don, in the "Gardener's Dictionary," places *Rhus copallina* in the dicœcious section, with the poison vines of Chapman, while Dr. Darlington, in "Flora Cestrica," styles all the species "polygamo-dicœcious." As these terms are employed in the sectional characters, their use is perplexing to the student. After a careful examination, extending over some years, I have found no case in which an isolated plant produces seeds. The plants are all truly dicœcious, and the terms hermaphrodite and polygamous applied to any Rhus are misleading, and should be abandoned. Often, isolated plants will be found in which the car-

[1] Proceedings of the American Association for the Advancement of Science, Vol. XXII, pp. 73–75.

pels appear perfect, but are hollow by reason of not having been fertilized. In some flowers the stamens appear antheriferous, and this fact has probably led to the belief in hermaphroditism, but I have never found one to be polliniferous.

Close inspection this season of some twenty-four plants of *Rhus copallina* led to observations of a novel character, worth recording. There were twenty-two female, and only two male plants. There are three pistils in the female flower. One of these is larger and deeper colored than the other two. These two finally abort, only a single carpel reaches perfection. The brown papery anthers are devoid of pollen, and have either no filaments or very short ones. Between the staminate cycla and that forming the gynœcium, are glands, seemingly an undeveloped series of stamens. These exude a great abundance of sweet liquid, which attracts honey-bees and other insects in large numbers. I have counted twenty honey-bees at work at once on a single panicle, many of them falling victims to the soldier beetle, *Reduvius novenarius*, which finds the Rhus a fertile hunting ground.

The male flower is especially distinct from the female in having no honey glands. The highly polliniferous anthers are on five long exserted filaments. These filaments are erect, and the anthers approach, forming a sort of crown, as if to protect the pistils which are in a depauperate condition beneath. The profusion of golden pollen is very conspicuous in these male flowers. In the female flowers the sepals are ovate and spreading, while in the males they are lance-linear and recurved. The rachis and pedicels are more slender and longer than in the female.

Considering the abundance of pollen, it would seem almost certain that at some time or other pollen-gathering bees would visit the male flowers, but whenever I saw them at work, it was only on the female plants. The abundance of liquid from the floral glands seemed an inducement to greater exertion, and watching these creatures on *Rhus copallina*, gave me, for the first time, the impression that there were times when these ever industrious creatures make special effort.

The subject of the relation of insects to flowers naturally thrust itself on my attention during these observations. Sweet secretions in these flowers certainly can have no significance as a means of insect attraction for the purposes of cross-fertilization, or of fertilization of any character. Insects seem to serve no object of the

plant in any direction whatever, while the female plant has to depend on the wind for its fertilizing material.

The sap between the bark and the wood, both in this and in other species of *Rhus*, is very sweet and particularly abundant, and on the slightest scratch, courses down the branches; in gathering it insects almost fight each other. The little exuding through the glands seems the result of an effort to get rid of a superabundance, and without any special significance in the economy of the plant.

Rubus chamæmorus.

Authors have variously characterized this plant. Thus, Don (1832) notes it as diœcious, Beck (1833) monœcious, while Michaux (1803) and Torrey (1826) leave the inference that it is hermaphrodite. Lightfoot, in "Flora Scotica" (1787), says, "This plant is diœcious above ground, but, according to a curious observation made by Dr. Solander, the roots of the male and the female unite together under the earth so as to render the plant truly monœcious." Dr. Gray (1867) regards the plant as diœcious. It did not matter so much, in the past generation, about special accuracy in these particulars, but in more recent times, when these questions enter largely into botanical philosophy, more accurate diagnoses are desirable. Specimens brought to me by botanical friends at Seal Harbor, Maine, show the plant to run extensively by underground stolons; one flowering branch with dried flowers producing no fruit, and another with berries from the same stolon, indicated that Solander was right in giving it a monœcious character without, however, the necessity of calling in underground grafting to account for the phenomena. The male "canes" appear to have been longer than the fruit-bearing ones. Dr. Gray, in the sixth edition of the "Manual," makes a subsection in which this species is placed, the flowers having a 5-lobed calyx. In all the specimens brought me each had but four lobes. Residents of Mt. Desert Island call the fruit "baked apple berries."

Dalibarda repens.

No author gives the slightest hint of any irregularities in the flowers of *Dalibarda repens*, though its relative on the one side, *Rubus*, has a monœcious representative in *R. chamæmorus*, and on the other side in *Fragaria chilensis*, and often in *F. virginiana*.

Confined to my room, at Seal Harbor, Maine, in August of the present year, by temporary illness, good botanical friends, and espe-

cially Mr. John H. Redfield, brought me generously large amounts of fresh plants, their daily collections. One of these, which I had no subsequent opportunity to see growing, was *Dalibarda repens*. My observations are therefore, wholly from these few plants, though the facts have been subsequently confirmed by Mr. Redfield.[2]

The single flower on the four to five inch scape, was found wholly staminate, the stamens being very numerous. The scape branched at the base, having what we might term a pedicel of an inch or so in length, recurving and bearing small cleistogene buds. These were found to contain but five short stamens, and the anthers, polliniferous, pressed down on the stigmas. These bud-bearing pedicels grew into the rotten leaves beneath the foliage, and matured the seed vessels beneath the surface, just as many violets do, bringing to mind that Michaux's name of *D. violœoides*, was still more expressive than even that author supposed.

As many of these subterranean seed vessels were ripe, it shows that cleistogamy commences quite early in the season, how early has yet to be ascertained. The earliest ones, it would seem, must have the flower on the 5-inch scape perfect, as the descriptions given by authors, no doubt, were drawn from these, and are given as with all the floral organs perfect. My rough notes, made on the spot, say, "the female or fertile flowers, with becoming modesty, withdraw into privacy beneath the ground, while the foppish male flowers seem to have no office in life to perform but to make a show of themselves." It may be remarked here, that in many cases of plants bearing cleistogene and fertile flowers they at some time produce what are regarded as normally perfect flowers, and these are supposed to be for the purpose of enabling the plant to get a chance to bear cross-fertilized seed. But so many of these are wholly infertile, while this *Dalibarda* is absolutely masculine, that it would seem that the fact may be capable of some other explanation.

On Some Morphological Distinctions in the Genera of Ericaceæ.

The sub-orders of Ericaceæ divide naturally into the free or the adherent calyx with the ovary, but an examination of various members of the order indicates a suppression or multiplication of series

[2] As these pages are going to press, Mr. Redfield notes that Dr. Gray has recorded the finding of *Dalibarda repens* cleistogene by Mr. Pringle.

of organs, and the impressment of one set into the service of another to such a degree that the morphologist will find little in an original type to divide into sections. *Monotropa uniflora* represents a section where the calyx is free from the ovary. The ovarium is described as being 10-grooved, but it is evident that this grooving is the result of ten staminal scales which have become adherent with the ovarium. To describe the flower properly we might begin with the 5-carpellate ovary. Though the "stigma" is usually described as being single and funnel-form, it would seem that a strictly correct form of expression, from the morphological standpoint, would be that there were five stigmas, united by a thin membrane into a circular, web-like disk. In the flowers before me there are ten stamens, but these are certainly in two series of five each, one set rather larger than the other. The upper and larger series alternate with five of the scales, and press the anthers close up under the fine stigmatic portions on the edge of the disk, and in this way effectually secure self-fertilization. The next series of five are shorter, and always keep the anthers free from connection with the stigmas. Both series of stamens, however, have the hairy filaments curved in toward the ovarium as if they also would have become adherent scales if they had had a fair chance. At the base of the ten stamens, and alternate with them, are ten horn-like processes, evidently each alternate one being slightly smaller than the other, representing two series which we may term either abortive stamens or abortive petals, as suits best the morphological view. These, however, curve outward and downward instead of inward, and should possibly be classed with the corolliferous rather than the staminal system which, as above noted, possesses an incurved tendency. From the apex of these glands, however, a large quantity of sweet liquid exudes and they might be termed "nectaries," if there were any separate place for such organs in the morphological type. There are five petals and it is singular that three of these seem always to be twisted, folding over each other from right to left while one petal is usually backed by the two adjoining (imbricate) plates, the edges of these almost meeting behind the petal which they enclose. Outside of these we have the remains of five sepals, varying so much in size that occasionally but two can be recognized.

It will be seen that this conception, as fortified by observation, makes the flower far less of a departure from the usual types of Ericaceæ, and places the genus more in harmony with its fel-

lows. Comparing the points here made with specimens of *Gaylussacia dumosa* before me, the stigma may be seen to be disc-shaped, as in *Pyrola*, with, however, ten stigmatic points on the margin of the disc, indicating a 10-carpellary structure. The ten flat anthers press closely against the style, and can be safely taken as the analogues of the ten adherent scales through which the pistil seems to protrude in *Monotropa*.

Taking up now *Pyrola rotundifolia*, we find, in the earlier stages, such a wheel-shaped disc in the stigma as may be seen in *Monotropa*, but with age they advance beyond the membranous connective and thus give us the "5-rayed stigma" of authors.

If we now take up *Moneses uniflora*, the "ten stamens" are found to be in series. Two of these series consist of three stamens each, two series of but a single stamen each, but occasionally there are two stamens in each of the latter sets, which make the full complement of ten, and we see here the tendency to a suppression of parts is very strong.

The whole lesson teaches the morphological unity of type in the sections of Ericaceæ to a greater degree than usually supposed, and that the cohesion or freedom from cohesion of the various cycles comprising the theoretical foliar system is the chief governing influence in the formation of genera in the order.

Vitality of Seeds. Lysimachia atropurpurea.

That seeds will live long in the earth in many cases is a general belief, but too frequently the facts presented are open to objection. Direct and incontestible evidence is still desirable. I am accustomed to sow seeds for the purpose of botanical examination and for specimens. In 1886 I had a few plants from seeds of the European annual, *Lysimachia atropurpurea*. After a study of the plant no further seeds were collected. In the winter following, this part of my garden was given up to building operations, and the earth filled in, several feet in depth, over where the Lysimachia grew, and on this large evergreens were planted. Last spring one of these evergreens was removed and a hole left, nearly two feet deep. In the bottom of this hole a Lysimachia plant came up this summer. There can be no other explanation than that the seeds had been there six years, as no Lysimachia has been growing in my garden since.

For some days prior to August 22, I took the plant under close examination from day to day. That plants do not grow continu-

ously but advance from stage to stage by leaps—making considerable rests between the stages—is well illustrated by the flowers of this plant. After the flower bud has reached a stage ready for expansion, it rests for a day but the style continues to grow and pushes through the closed flower bud to the extent of about two lines. Then it rests, and the corolla opens and assumes an erect campanulate form. The stamens grow as the petals lengthen, but continue growing for a day after the corolla is at rest, continuing till they exceed the style, the anthers forming a close circle just above the stigma, when they discharge their pollen over it. As every flower is fertile, and the plant produces seeds profusely, I surmised that the flowers must self-pollinate but the advance of the pistil, with its evidently receptive stigma, so long before the maturity of the anthers, seemed theoretically against this view. In a large area of these flowers, where some plants in bloom would mature in advance of the others, insects might convey the gelatinous pollen to the exposed pistils on other plants. In this one specimen, however, there were no insect visitors observed except an occasional sand wasp, and the effect was only to help the stigma to its own pollen. This plant was certainly self-fertile, though the conditions seem to be such that it might be cross-fertilized under favorable circumstances.

Campanula rotundifolia.

A large branch of specimens, placed in water for a week, presented some remarkable variations. The lobes in most instances were about one-fourth the depth of the campanulate corolla, in some instances one-third. In one case the corollas on the stem were cut to fully one-half their length, and the lobes spread so that with a little more effort the corollas would have been rotate! The flowers of this species of *Campanula* are centrifugal, the terminal one opening first. A number of these terminal flowers were 10-lobed with ten stamens, still more with six lobes and six stamens, but the majority were normal with five lobes and five stamens. In one flower with five lobes, the five stamens had been transformed to petals, and it is worthy of note that these five were separate and not united into a monopetalous corolla similar to the outer series. On the same stalk, another flower had two of the stamens somewhat petaloid instead of antheriferous. Two other flowers on the same stalk were normal.

Although the flowers of *Campanula rotundifolia* are classed as proterandrous, the pollen is not ejected from the anther cells till after the corolla has opened and the hairy pistil has been developed considerably beyond the line of the anthers, though most of the genus seem to discharge their pollen while still in the bud. The stamens wither soon after the anthers have discharged their pollen. In the flowers in this large branch the stigmas do not expand till the fourth day after flowering. In the quiet atmosphere of the room and in the absence of all insects that are usually considered aids in fertilization, there seems to be no pollen on the stigmatic surfaces, but capsules are all enlarging, and the young seeds swelling as if the fertilization of the flowers had been perfected. It is difficult to believe that in some manner fertilization has not taken place. Only the full ripening of the seed could positively prove this point. Unfortunately I had not the opportunity to test it.

The variation of the color in the flowers of this branch may be noted. During the week that I had them under observation, there may have been between two and three hundred flowers. Some were nearly white, others of a rosy purple, the majority blue. The observations were concluded on the 15th of July.

CORNUS CANADENSIS.

Some of the exotic species of *Cornus* are diœcious, but there is no record of diœcism in any of the American species. The plant is very common on Mt. Desert Island. Near Northeast Harbor I spent several hours, July 27th, examining these plants particularly, amongst other things, and would frequently find large patches that were evidently the production of several years by underground stolons, entirely barren. Other patches would have a single berry in the central portion of the cyme and all the others barren. Other patches were abundantly prolific. It is a safe inference that some plants are monœcious and others wholly diœcious.

As it is well understood, the leaves are really in opposite pairs, the verticil being formed by the suppression of the internodes and axillary buds. One specimen was found in which two axillary buds had produced branches, and these two again produced each two more from their apices. These four branches were terminated by four heads of flowers, each with its four milk-white bracts which in the midst of so many companion plants with numerous red berries had a unique effect.

As in the great dogwood, *Cornus florida*, some of the bracts are shaded from light-rose to deep pink, as appeared from some belated flowering plants.

The so-called "bracts" of these species of *Cornus*, as I have noted elsewhere, are not true bracts but merely simulate them. They are flower bud scales which have taken on renewed growth, carrying along the earlier formation which, during the winter, acted as a bud scale and which, in the spring season, gives the dark obtuse apex to the "bract."

Aralia hispida.

An interesting feature in many plants is that while the inflorescence, as a whole, may be centripetal the flowers themselves are centrifugal. *Aralia hispida* is a good illustration. While the terminal umbel is the first to flower, the flowers themselves in each umbel are centrifugal.

Of special interest in this species is the fact that while all the male flowers have but five stamens, fully one-fourth of the female flowers have six carpels.

Luzula campestris.

The appendages at the base of the seeds in some species of *Luzula* are well known. It occurred to me to endeavor to ascertain their special function. No theoretical conception as to their function or place in the economy of plant life could be satisfactorily formed. A novel point seemed to be that long after the flower stalk had become dry, and the valves of the capsules expanded, the seeds were held in place by the appendage, hanging loosely from side to side as the capsule might be turned about. While so many plants have arrangements for projecting seeds from the capsules, it seemed remarkable that this should be specialized to retain them.

Cakile americana.

The flowers being unexceptionally fertile led me to infer that they were self-pollinate. Examining a large number at Atlantic City in the middle of June, I found this to be the case. The anthers press against the stigma and cover it with their own pollen before the bud expands. A remarkable feature in the Atlantic City flowers is the comparatively small size of the petals, and in a large number of flowers only a single pair of petals are produced, the flowers losing in these cases their cruciferous form. At Seal Harbor, Maine

a month later, no bipetalous flowers were noticed, but the same fertilization in the unexpanded flower occurred. The Maine plants have a more zigzag habit of growth, and the leaves are more dentate (in many cases pinnatifid), than in the Atlantic City plants.

HYPERICUM ELLIPTICUM.

Generic characters, like those of species, are often found running so close together that it is difficult to draw a dividing line. No one would question the propriety of separating *Ascyrum* and *Hypericum*: *Ascyrum*, "sepals four, very unequal;" *Hypericum*, "sepals five, somewhat equal." In this species there are really but four sepals, but a minute bract does duty as a fifth sepal. The sepals are almost as unequal as those of any species of *Ascyrum* could be.

TRIFOLIUM HYBRIDUM.

So much has been said of the relations between insects and the flowers of clover that more would seem superfluous, but of *Trifolium hybridum*, the Alsike or Swedish clover, few observations have been specially recorded. Of late years this species has become common on Mt. Desert Island, at least it is very common about Seal Harbor, where the unusual beauty and fragrance of the flowers press it closely on our attention. Observing that every flower seemed fertile, I anticipated self-fertilization, and found that this was the case. In the unopened bud, just before the expansion of the petals, the stamens and pistils are of equal length. The anthers press closely against the stigmatic surface of the pistil and discharge the pollen therein before the flower opens. After expansion the flattened keel presses and keeps pressed together the stamens and pistil, preventing any exposure at any time. The stamens and pistil remain thus entombed through life, dying eventually in each other's arms. If an insect or the thumb nail be pressed against the base of the keel the pistil and stamens are set free, but only to expose the pollen-covered stigma. Many species of plants have their stamens and pistils so arranged that, though close fertilization is the rule, the use of foreign pollen is not an absolute impossibility, though, when we consider how few seeds of a crop ever get a chance to grow again, the physiological value of an occasional cross on a seed which has small chance of ever growing is not apparent. But even this chance is lost to this species of clover as found growing here in July, for the abundant fertility is certainly due to self-pollination, and cross-fertilization is wholly out of the question. Bees do not

seem abundant in this locality. Only a small species of bumble-bee was observed at any time, and none visiting these clover flowers.

LATHYRUS MARITIMUS.

I have pointed out in previous contributions that when leaf-growth is arrested to form bud-scales, sepals, or petals, the laminal portion or blade usually becomes effete, and it is usually the stipular portions or dilated bases of the leaves that are transformed to do the protective work. In *Lathyrus maritimus* this is particularly obvious, the large stipules being fully formed, and acting as protectors of the young buds, even before the rest of the leaf-blade is developed. If no leaf-blade proper were produced at all, and the axial growth arrested, these stipules would be reduced, and then properly be termed bud scales.

Many species of *Lathyrus* are on record as being self-fertilizers. No note seems to have been made of *L. maritimus*. At Seal Harbor every flower seemed fertile, indicating self-fertilization. Unless the flowers are disturbed the stamens and pistil remain to the last wholly enclosed by the keel. When, however, a visiting insect presses the keel downward, the upper portion of the style projects considerably beyond the apex of the keel, but the stamens remain wholly included. An insect in search of honey, covered with pollen beneath, might then easily cross-fertilize the flowers, but as the anthers seem never exposed in these flowers, so far as I could ascertain, there is no pollen collected by the bee for transmission to another flower. A peculiarity of this species seems to be that the vexillum presses down and clasps the keel in the earlier stages of anthesis, preventing the ingress of insects, and it is only in the later stages, after self-fertilization has been fully accomplished, that the vexillum becomes erect, and the entrance of insects permitted. This species will have to be classed with those already admitted to be absolutely self-fertile.

LONICERA CŒRULEA.

It is many years since I handed to our good friend Professor Asa Gray, some evidence, as I supposed, questioning the soundness of the belief that leaf blade has its primary origin at the node from which it seems to spring. The sententious reply I shall never forget, "nevertheless, I maintain that decurrence is decurrence." For all the overshadowing eminence of this great and good man facts continually come before me that seem inexplicable under the

accepted hypothesis. It seems to me that the origin of leaf-blade must be at some indefinite place below the point of departure from the axis, and that "decurrence" is simply the effect of an irregular meeting of the edges of the clasping leaves. In the case of plants which have the young branches square or flat-stemmed, but round in their after stages, it would seem that the only way of accounting for it is by conceiving the union of the edges of the blades as they clasp the stem.

An examination of some specimens of *Lonicera cærulea* brought me at Seal Harbor by Mr. Redfield July 22nd, clearly demonstrated that this was the case. The growth of the present year is square-stemmed. In cutting the stems across, mid-way between the nodes, the costa of superposing leaf is clearly seen. The scales, at the termination of the season's growth suggest this behavior also. They are boat-shaped, evidently formed from a theoretically dilated base, and meet by their edges. Later on, incipient leaf-blades may be seen starting from their terminal points. That with a little modification these scales could have been elongated, become united at the edges, closely clasp the real bark, and then by the formation of leaf-blade diverge at the node, seems so plausible that there is little doubt that this has been the process during the vigorous growing season.

I have shown elsewhere that the rifting of bark is not a mechanical operation due to the growth expansion of the stem, but that provision is made in true bark for this rifting by the formation of suber cells which develop after a certain number of years have elapsed, and which disintegrate the bark and thus permit the expansion of the wood beneath. Every ligneous plant has, by a specific growth of these suber cells, its own special manner of providing for the opening of its bark. In *Lonicera cærulea* and similar plants with square stems, or decurrent leaves on the young growth, there are none of the suber cells on the external epiderm which truly formed bark should have. In the specimens brought me the "square" or external layer had not been thrown off, and by a little help from the knife, I was able to detach the whole from a branched specimen, just as if it had been a paper mask. This epiderm, having no cork cells, has to burst by drying or by the expansion of the woody axis, and the rupture is down the weakest line of union, namely, where I have conceived the hypothetical union of the edges to have been. The square stem is then changed to a round one, the epiderm of

which is strewn with minute ovoid nests of cork cells. From the well ascertained facts as to the manner of bark formation the outer epiderm could not possibly have been formed in the same manner as the hypoderm, namely, by the differentiation of the horizontal cells, but could only have originated from an independent exogenous growth, such as a supposititious enclosure by a clasping leaf-blade could produce. Aside from these considerations the continuity of the nerves in this intra-nodal sheath with the nerves of the leaf-blade indicated, clearly shows the identity of their origin.

It may be said in brief that while plants, generally, in their first year's growth, have only two separate systems—wood and a single layer of bark—a section of *Lonicera cærulea*, and plants constructed on a similar plan, have three, the outer layer of which, by the absence of suber cells and other characteristics, clearly is not true bark. There seems to me little doubt but square-stemmed annual growths or the appearance of decurrence on growing stems, is due to the fact that the leaves have really originated below the point from which they seem to emerge, and that the angularity or decurrence is due to the more or less imperfect meeting of the edges of these leaves when clasping the stem.

Raphanus sativus.

The garden radish is admittedly self-fertile, but noting on the 14th of August an unusually large number of the cabbage butterfly (*Pieris rapæ*), as well as several other Lepidoptera, about them, I was led to make an extended observation with some novel results. There were a large number of plants in the row under observation, and the remarkable difference in fertility in the different plants, first attracted my attention. In some cases, possibly three-fourths of the flowers had produced seed vessels, in others, about half, while some plants had only a few scattered pods. As the plants were still flowering freely, good opportunity was afforded to see how far sexual conditions might influence these several characteristics. There were found some remarkable morphological peculiarities worth noting.

In one flower one of the basal glands had developed to a perfect pistil, which was half the length of the normal one! As there have been different views of the nature of these glands, may we not regard them as undeveloped axillary buds? In this flower instead of four long and two short, the whole six stamens were of equal length.

Another flower had but three long stamens, and these a little longer than the pistil at this stage of blossoming. Of course in this,

as in many cruciferæ, the capsule elongates after petals and stamens fall. The two short stamens were normal.

Another flower, in addition to the normal six stamens had two of the petals antheriferous. There was but a very slight attempt at petal bearing. It is worthy of note that the insertion of these antheriferous petals was much more nearly opposite the glands than usual, indicating that a disturbance of the spiral growth co-existed with the abnormal condition of the petals.

Three flowers had a third gland. In one flower the third gland was only half the size, but in other respects similar to the others; in the other two the extra glands were long and horn-like, as if they were partially developed pistils.

Another flower had three long and three short stamens. Two flowers were found with three series of stamens, each series of two, of different length. In these the upper pair curved inward, touching the stigma by the upper portion, the anthers, however, recurving from the pistil.

A flower with four glands was another surprise. One of the two normal ones was unusually large and 5-lobed at the apex. The two extra glands are between the shorter pair of filaments.

Another had the four long filaments colored like the petals, while the filaments of the two short were white and transparent.

It is well to note that while the insertion of the short stamens is always under the normal glands, the extra glands are between the pairs, indicating that they belong to a distinct cycle from the other two.

Examining the flower-bud while comparatively young, a unicellular transparent hair is found at the apex of each sepal, which is early deciduous, leaving a bulb-like base, which might easily become a "gland" under some morphological change.

The upper portions of the filaments connive, and might without close examination be regarded as united. It may be noted that on the opening of the flower the lower portion of the sepals separate first, leaving the upper portions to connive to the last. In some flowers the sepals remain united to the last, and are monosepalous.

In a number of plants which had only a few seed pods on them, the anthers were evidently barren. These plants have had these few fertile flowers pollenized by insects. In other plants the four long stamens would be barren, while the two short stamens would have abundant pollen.

The conclusion left on the mind of the observer was that some plants of the radish were arranged for self-fertilization, and others required the intervention of insects, but that this so-called "arrangement" was brought about through various phases of nutrition affecting the growth of different portions of the plant, and in which special arrangements for fertilization had no primary place.

ON THE NATURE OF THE VERRUCÆ IN SOME CONVOLVULACEÆ.

The stems of some Convolvulaceæ, notably the one in common cultivation as "Moon-flower" (*Calonyction speciosum* Choisy, *Ipomœa Bona nox* Linnæus), are verrucose. No explanation of the nature or functions of these warty processes has ever been given, so far as the knowledge of the writer extends. Horticulturists who have given any thought to the matter have regarded them in the light of attempts at root formation or as somewhat akin to the rootlets along the branches of ivy; but these have been only passing impressions. A critical examination, however, shows that they have no central system, as true rootlets have, nor have they a root-cap, as we find on genuine fibres.

It occurred to me to note the behavior of *Cuscuta*, when growing where it could not readily find a host plant. It produces haustoria ready to fasten on its victim when the opportunity might offer. The structure of these processes and those of *Calonyction* seem identical. As it must be conceded that *Cuscuta* is a genus of degenerate Convolvulaceæ, or rather a genus of plants that has come in the course of ages to be able to live on other plants, it does not seem improbable that these seeming excrescences on the *Calonyction* may be incipient haustoria, and that in the future other Convolvulaceæ besides *Cuscuta* may become parasitic. It must be said, however, that in many examinations I have made where these supposititious haustoria have been brought into close contact with other growing vegetation to such an extent, in some instances, as not to afford room for the usual longitudinal development, the excrescences have become flattened rather than make any attempt to penetrate the tissue of the approximating plant. This, however, may not militate against the supposition that these warty excrescences are incipient haustoria, unless the proposition that in plants environment, or more properly, perhaps, environment to a great extent, is the leading factor in the evolution of characteristic forms. Such a proposition, to my mind, implies that the change in form

should be responsive at once to the force that induced it. One can scarcely imagine a change in form to occur in a plant, responsive to irritation received from external causes by its ancestors hundreds, perhaps thousands, of generations previous. But if we take the succession of forms we know to have occurred, and know to have been evolved from closely related forms, as following in obedience to some law of growth as yet hidden from us, we can have no difficulty in suspecting that when the fulness of time shall arrive these analogues of haustoria will have full parasitic functions.

POLYGONUM CILINODE.

In a few instances, by no means common, I found July 12th at Seal Harbor, Mt. Desert Island, branches of *Polygonum cilinode*, which instead of being climbing were sarmentose, and, bending over, had rooted at the tip and formed a large terminal bud as we find in some species of *Rubus*. Many were found of a sarmentose or trailing habit, with no disposition to climb, though the facilities for climbing were within reach. In among the ramifications of the roots of these rooting tips were numerous cleistogene flowers, perfecting sometimes wholly underground. The flowers in the climbing branches are of two kinds as I have noted in other Polygonums, one always closed and fertile, the other open, apparently perfect in all respects, but barren. The inflorescence is formed of continuously branching axillary buds, and the only check to a further continuance of growth, seems to be exhaustion. The growth ends with depauperate buds. The species is evidently on the border line evolutionarily speaking between the merely upright and the climbing species.

ASTER TATARICA.

This Asiatic species exhibits in its inflorescence a curious mixture of characters separate in other species. The upper portion of the panicle is corymbose and comprises about a dozen flowers, which are centripetal, the central flower opening first. The flowers are quite gay with their numerous violet-colored rays. The lower flowers on the outer branches of the corymb, are, however, rayless; below this corymb is a conical panicle of a foot or more in length. The lower branches of this panicle extend six inches or more, and these lateral branches gradually shorten till they are scarcely an inch long. These branches are all centripetal in their growth from the central axis, but the flowers are centrifugal. In all the upper flowers,

those on the shorter branches of the panicle are discoid, as are the lateral ones on the branchlets.

The explanation seems to involve the question of rhythmic growth. Rest had been nearly reached at the point represented by the

apex of the cone, when the new flow of growth resulted in the terminal corymb.

To form the centripetal character of the inflorescence the axillary buds remain at rest until the branch has reached its final length,

when the growth wave returns, starting each bud again to development in this reflex action. As it is the lower and more slender pedicelled flowers which are discoid, nutrition has evidently determined the absence of rays, but whether this point was decided during the upward or the reflex movement of the growth-wave could not be determined, though the former seems the most probable.

The annexed figure from the dried specimen on the table shows the conical growth of the panicle almost to a rest, and the subsequent resumption of active growth to form the terminal corymb.

PRELIMINARY OUTLINE OF A NEW CLASSIFICATION OF THE HELICES.

BY HENRY A. PILSBRY.

For several years the writer has been accumulating data bearing upon the natural classification of the Helicoid land snails. It has been thought desirable to place before students of this group some of the general results attained, and to invite their friendly criticism.

It will be understood that the consideration of many important points, such as the relations of Helices to certain Bulimoid groups, must be omitted from so brief and synoptical a paper as this; the author's aim being simply to place before malacologists the outlines of a classification essentially modern and essentially original. It can scarcely be expected that an arrangement in which most of the traditions of our Fathers in Conchology have been disregarded, will prove acceptable to all, or, indeed, in all respects worthy of acceptance; but it is hoped that it will be found an improvement on previous systems.

The anatomical details of numerous groups herein for the first time described will be figured in the author's more elaborate work now in preparation, to be issued in 1893.[1]

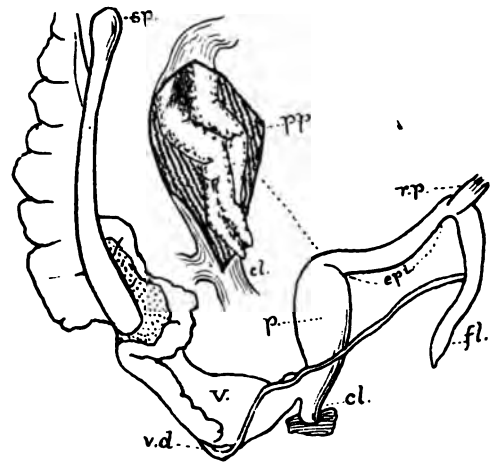
The notes given below under each genus must not be taken for complete generic diagnoses. I hold that for the establishment of genera the characters of the shell must be taken into account, as well as those of the genital system and of the jaw and lingual ribbon. For the formation of groups higher than genera, certain modifications of the genitalia seem to be most constant and availa-

[1]The principal authorities consulted are the following:

Binney, W. G., Terr. Moll. U. S. vol. V, etc.
Pfeffer, Georg, Beitr. zur Kenntniss Mex. l. u. fr.-w. Conch., etc.
Fischer, Paul, Numerous papers in the Jour. de Conch. and Moll. Mex. et Guat.
Hedley, Chas., Proc. Roy. Soc. Queensl. and Proc. Linn. Soc. N. S. W.
Hutton, F. W., Trans. N. Z. Institute.
v. Ihering, H., Morphol. u. Syst. des Genit. von Helix. This paper, the *erster Thiel* of which is before me, is a very valuable one and indispensable to the student of Pulmonate morphology.
Lehmann, Die Lebenden Schn. Stettins.
Pilsbry, H. A., Proc. Acad. Nat. Sci. Phila., 1888–1892.
Schmidt, A., Des Geschlechtsap. der Stylom.
Schako, G., Numerous papers.
Semper, C., Reisen im Archip. Phil. Landmoll.
Suter, H., Trans. N. Z. Institute.
Tapparone Canefri, C., Annali Mus. Civ. Genova.

ble. Before proceeding with the descriptions of genera it may be well to describe briefly the organs to be discussed.

In the accompanying figure, representing the genitalia of *Helix*



Camænella platyodon Pfr.

platyodon Pfr., a species of the island of Hainan, the male system is seen branching toward the right, the female system toward the left. The systems unite below, forming the *vestibule* or *atrium*, sometimes called genital cloaca (*cl.*); and they are also united above; the hermaphrodite gland or *ovotestis*, giving off both spermatozoa and immature ova which travel through the much convoluted hermaphrodite duct or ovisperm duct, to the base of the albumen gland, where the duct separates into oviduct and vas-deferens.

The *penis* (*p*) is in its simplest form a muscular sack receiving the *vas-deferens* (*v. d.*) and the retractor muscle (*r. p.*) at its summit. There are often developed upon the penis one or more of the following accessory organs: (1) the *appendix*,[2] a glandular or flagellum-like organ inserted at the middle or near the base of the penis sack (see this volume, plate 13, fig. *F*, at *x*, *x*.); (2) the *penis-papilla* (see *p. p.* of the annexed figure) seen only by splitting the muscular penis wall. This papilla is perforated near its base for the exit of the spermatophores; (3) the *epiphallus*[3] (*epi.*), a

[2]See v. Ihering, Morphol. u. Syst. Helix, i, p. 396.

[3]In the epiphallus the spermatozoa are gathered into variously covered masses, or spermatophores. Simroth calls the corresponding organ in the slugs the "*Patronenstrecke*."

slender continuation of the penis backward, extending to the insertion of the vas-deferens, and usually continuing beyond this insertion as a flagellum. The retractor is sometimes situated upon the epiphallus instead of at the apex of the penis itself, this arrangement being shown in the figure here given. (4) The *flagellum* (*fl.*) a whip-lash shaped organ inserted upon either the summit of the penis or upon the epiphallus. The female system consists of the *vagina* (*v.*), which bifurcates to form the spermatheca or *receptaculum seminis* (*sp.*), and the *uterus*, a sacculated organ often containing eggs or young in various states of development. Surmounting the uterus is the albumen secreting gland, at the base of which the hermaphrodite duct enters the oviduct and vas-deferens. Besides the organs above described, the female system in some groups possesses a *dart sack* or sacks secreting a dart, and one or two *mucous glands*, these organs being inserted upon the vagina. Another organ of rare occurrence is the *appendicula*, an elongated simple diverticulum also emptying into the vagina. This diverticulum is supposed by v. Ihering to be homologous with the *appendix* of the male system; and it is certainly strong evidence of the correctness of his view that no form yet known possesses both appendix and appendicula. It is further held by him that the dart sack in *Zonitidæ* is the homologue of the appendix; but this theory requires before adoption much stronger evidence than has been given.

From the foregoing it will be seen that the following points should be carefully observed when dissecting the genitalia of Helices: Shape of the penis and presence or absence of internal papilla and external appendix; presence or absence of flagellum or epiphallus; point of insertion of the retractor muscle and of the vas deferens. Upon the female system should be noticed the absence or presence and form of dart sacks, darts, mucous glands or appendicula; the length of the spermatheca duct; the form of the cœca of the ovotestis and whether they are imbedded in the liver or free; and finally whether the right eye-peduncle is retracted between the branches of the genitalia or to the left side.

The flagellum, the dart sack and accompanying mucous glands, and the diverticulum upon the spermatheca duct may be regarded as structures developed since the differentiation of the Helices from other stocks; but the appendix and probably the appendicula, when present, have been inherited from that primordial stock from which the Helicidæ, Pupidæ, Bulimi etc. have diverged. As is sometimes

the case with ancient characters, we find these features retained in a number of very dissimilar genera.

The characters and value of the jaw as a basis for classification have been much misunderstood in the past, and even yet there are a number of unsettled questions concerning it. On some points, however, we may speak with considerable confidence. One such is the fact that *the strongly ribbed type of jaw* (odontognath) *intergrades by imperceptible stages with the entirely smooth, Zonites-like type* (oxygnath). Examples illustrative of this dictum are numerous, the restricted section *Caracolus* of Eastern Cuba and Haiti and the section *Dentellaria* being unquestionable instances of intergradation, some species of each of these groups being typically oxygnathous, others being pronouncedly odontognathous. To W. G. Binney is due the credit of first pointing out the fact and insisting upon its implications. The writer has confirmed it by the examination of numerous additional species. It is hardly needful to say that in many groups of Helices, odontognathy and oxygnathy are therefore controvertible terms, as far as classification is concerned, and consequently cannot be used for the separation of genera or even subgenera, unless supported by other and more stable characters.[4]

The jaw composed of a number of separate and similar squarish plates, more or less overlapping at the outer edges (such as that of *Punctum*), is comparable to an *unsoldered* jaw of the plaited (or stegognath) type.

Primarily the Helicoids are divisible into a number of groups, as follows:

Eggs or young very large at birth (¼ to ⅓ the diameter of the adult shell) *Group I*, MACROON.

Eggs or young smaller or minute at birth.

a. ♀ genital system having a dart sack and mucous gland. *Group II*, BELOGONA.[5]

aa. ♀ system lacking accessories; ♂ system with flagellum and appendix on penis; no epiphallus. *Group III*, TELEOPHALLA.

[4] In some species of *Dentellaria* the sculpture of the jaw is not even constant as a specific character.

[5] The terms "Haplogon" and "Belogon" were proposed by v. Ihering, Morphol. u. Syst. Genitalapparates Helix, i, p. 401, 402.

aaa. ♀ system lacking accessories; ♂ system having epiphallus on penis; no appendix.

Group IV, EPIPHALLOPHORA.

aaaa. ♀ and ♂ genital systems lacking all accessory organs.

b. Jaw soldered into one piece.

Group V, HAPLOGONA.[5]

bb. Jaw composed of 16–24 separate plates.

Group VI, POLYPLACOGNATHA.

Group I, MACROON Pilsbry.

Manual of Conchology (2), VI, p. 57, 1890.

Arboreal or ground living Helicoids, reproducing by eggs of relatively very large size (one-fourth to over one-third the diameter of the adult shell) and few in number; sometimes viviparous. The embryonic shell is correspondingly large, and sculptured differently from the subsequent growth. Some genera now classed with the Bulimi may prove to belong here, besides the following:

Genus ACAVUS Montfort.

Oviparous; genital organs lacking all accessory appendages; duct of the spermatheca short. Jaw smooth. Teeth all simply unicuspid.

Subgenus PYROCHILUS Pilsbry.[7]

This group will probably prove to be a section or subgenus of the Ceylonese genus, as Dr. v. Moellendorff has pointed out. It is still unknown anatomically.

Genus STYLODONTA C. & J.

Viviparous; ♀ genital system lacking accessory appendages, but ♂ system having a flagellum upon the penis; duct of the spermatheca long. Jaw not ribbed. Median teeth unicuspid, but marginals bluntly trifid.

Distribution: Seychelles Islands.

Genus HELICOPHANTA Fer.

Group II, BELOGONA.

Female genitalia provided with one or two dart-sacks and mucous glands.

---

[7]This name is proposed to supersede *Phania* Albers, 1860, that term being preoccupied for an apparently valid genus of Diptera described by Meigen in 1824. Type, *Helix pyrostoma*.

Jaw coarsely ribbed (odontognath), finely ribbed (pycnognath), or smooth (oxygnath).

The appendages of the ♀ system mentioned above are developed in no other group of Helices.[8]

Genus HELIX Linne (restricted).

Pilsbry, Proc. A. N. S. Phila., 1891, p. 313.

Genitalia: ♀ system having a dart-sack or sacks containing darts, a pair of mucous glands or one, the spermatheca duct long and provided with a long diverticulum; ♂ system having a flagellum upon the penis, and rarely an appendix.

Jaw stout, strongly ribbed. Teeth of the radula normal.

Shell various; animal reproducing by many small eggs.

Only in the more highly organized species are all the above characters of the genitalia developed. In many sections of the genus several of the accessory organs may be absent. I am disposed to think that in some cases the genital system has arrived at a simple condition by degeneration or loss of the accessory organs. It is upon this ground that I admit *Cressa* West. (*Pseudocampylæa* Hesse, non Pfr.) to the genus.

The genus is more numerous in species than any other; and a large number of subgeneric and sectional groups have been instituted for their classification. The anatomy of a great number of species has been investigated, and a sufficient basis of facts is known to enable us to divide the genus into several well-marked subgenera, all of which are represented in the Palæarctic Region, which has been, no doubt, the birth-place of this type. As it is not my purpose to enter into the question of the subdivision of this genus here, I will simply enumerate the leading groups in the several geographical regions, viz.: (1) Eur-African, (2) East-Asiatic, and (3) American.

The EUR-AFRICAN area comprises the greatest variety of types, both recent and fossil, and the genus doubtless originated and developed its peculiarities therein. The more prominent subgenera or sections are as follows: *Arianta*, *Campylæa*, *Elona*, *Chilotrema*, *Isognomostoma*,[9] *Pomatia*, *Eremina*, *Macularia*, *Tachea*, *Iberus*, *Hemicycla*, *Leptaxis*, *Plebecula*, *Eulota*, *Fruticicola*, *Euparypha*, *Xerophila*, including many sections and a vast number of species,

[8] v. Ihering holds, I believe correctly, that the so-called darts of Zonitidæ are not homologous with those of these Helices.

[9] See Pilsbry, Journ. de Conchyl., 1891, p. 22.

and finally the peculiar forms of the Atlantic Islands: *Ochthephila, Tectula, Craspedaria*, etc., etc.

Here, too, belong the tertiary Helices which authors have always referred to *Coryda, Geotrochus*, etc., such as *H. rugulosa, crepidostoma, bohemica, hortulana*, etc., etc. The sadly mis-named subgenera *Dentellocaracolus* and *Prothelidomus* of Oppenheim also fall into the restricted genus *Helix*, near *Macularia* and *Leptaxis, Hemicycla*, etc. Boettger has criticised Oppenheim on the *conchology* of his "Paläontologisch–Zoogeographische Studie," but his zoo-geographical conclusions and implications are even more erroneous. It is time that we heard the last of this habit of going to the ends of the earth to find subgenera for the European fossil Helices! With the exception of a few divergent branches which apparently have left no descendants, all of the European tertiary Helices belong to subgenera still occupying some part of the Palæarctic realm, or at farthest the Holarctic area. The supposed *Corasia, Chlorœa, Eurycratera, Coryda, Dentellaria, Obba, Chloritis, Thelidomus, Mesodon, Triodopsis*, etc., which have been reported from the Eocene, Oligocene and Miocene of Europe, belong in no case to those groups, but, for the greater part to the genus *Helix* as above restricted. Many of them can readily be referred to recent subgenera and sections, such as *Campylœa, Gonostoma*, and especially to that primitive stock called "Pentatænia" by Schmidt and Sandberger, from which sprung the *Tachea, Macularia*, etc., of the recent fauna.

The EAST ASIAN area of distribution is in reality connected with the Eur-African, by way of Siberia, but as the species of the intermediate region are few on account of its at present unfavorable climatic conditions, the connection is not effective in preventing divergence of types. We therefore find that the East Asian forms belong mainly to distinct subgenera or sections. The European *Eulota*, however, is very closely allied to *Dorcasia* (+ *Acusta*) of Asia; and the Chinese section *Metodontia* Mlldff. is scarcely separable from *Petasia* (*H. bidens*, etc.) of Europe. We also find closely allied species of *Vallonia, Carocolina*, etc., inhabiting China and Europe. Besides the above mentioned groups, the following are to be referred here as sections of *Helix: Plectotropis* Alb., *Aegista* Alb.,[10] *Cathaica* Moell., *Satsuma* Ads., *Euhadra* Pils. (type *H. peliomphala* Pfr.).

[10]See Proc. A. N. S. Phila., 1892, p. 214, pl. 13, figs. G. H.

In AMERICA, the genus *Helix* is restricted to the West Coast[11] until Mexico is reached, where the species spread over the middle portion also. In South America the species are sparsely distributed. *Lysinoe* is the most prominent subgenus, including the larger Mexican and Californian species. *Epiphragmophora* occurs in South America; and the West Indian *Eurycampta* may perhaps belong here. Among the fossil forms may be mentioned the section *Glyptcrpes* Pils., proposed for *Helix veterna* M. & H.

The writer has elsewhere[12] expressed the opinion that the American forms of true *Helix* reached this continent from Asia by way of a land bridge in the region of Bering Sea.

Subgenus GONOSTOMA Held.

Differs from *Helix* in the less complex genitalia and the white-lipped shell.

Genus LEUCOCHROA Beck.

This genus is allied to the restricted genus *Helix* in genitalia and dentition; it differs in having the jaw entirely smooth, with a low median projection. The characters separating it from *Helix* are not great, and have generally been much overestimated. It has often been said to be near *Zonites*, but this supposition is utterly without foundation. The species are mainly circum-Mediterranean, the best known being the common *L. candidissima*.

Genus ALLOGNATHUS Pilsbry.

Man. of Conch, (2), iv, p. 121, 149, 1888. Kobelt, Nachr. bl. D. M. Ges. 1891, p. 140.

Genitalia: ♀ system provided with two digitate glands each two-fingered; dart-sack having a four-bladed dart; duct of the receptaculum seminis bearing a long diverticulum. ♂ system having a long flagellum.

Jaw entirely smooth, slightly projecting in the middle.

Radula very large; teeth all of the same form, which is that of a semicircularly curved strap.[13]

The genital system is that of *Helix* s. str., resembling *Campylæa* as much as anything; but the smooth jaw and especially the extremely peculiar dentition, are sufficient to give generic rank.

[11]See Proc. Acad. Nat. Sci. Phila., 1888, p. 193.

[12]Check-list of Amer. Land Shells, p. 195.

[13]See Schuberth, Arch. f. Naturg. 1892.

The only species known is *A. grateloupi* Grælls (*grœllsiana* Pfr.), of the Island of Majorca. Probably *H. quedenfeldti* Mts. belongs here, also, as Kobelt suggests.

Genus COCHLOSTYLA (Fer.) Semper.

Genitalia: ♀ system having a globular mucous gland united with the dart-sack; ♂ system usually without a flagellum. Jaw strongly ribbed, rarely smooth. Brilliantly colored shells of arboreal habits, confined with a few exceptions, to the Philippine Islands.[14]

Genus POLYMITA (Beck) Binney.

Genitalia as in *Hemitrochus*. Jaw low, wide, arched, delicately striated, without ribs or median projection.

Teeth with a long quadrangular basal plate with gouge-shaped expanded cusp.

Shell globose, brilliantly colored, with simple lip.

This genus holds much the same relation to *Hemitrochus* that *Allognathus* holds to *Helix*. The extremely peculiar dentition, first made known by Binney, is very different from that of ordinary Helicoids, but is approached by a number of other fruit-eating arboreal snails. The species are all Cuban.

Genus HEMITROCHUS (Swainson) Pilsbry.

Man. of Conch. (2), V. p. 5. Proc. A. N. S. Phila. 1892, p. 129, pl. 6, figs. F, G.

Genitalia: ♀ system having a dart-sack and accessory mucous glands; duct of the spermatheca long, simple. ♂ system having a slender penis at the apex of which the vas-deferens and a long flagellum are inserted; retractor penis lacking.

Jaw highly arched, smooth except for some faint vertical striæ in the middle.

Dentition of the normal Helix type.

This group includes the sections *Hemitrochus*, s. str., *Plagioptycha*, *Dialeuca*, *Coryda*, and perhaps *Jeanneretia*. Possibly the continental section *Oxychona* belongs here. The species are all West Indian, inhabiting from Jamaica and Haiti northward to the

[14]Under *Cochlostyla* are included the sections enumerated by Semper (Land Moll. Phil. Arch.), several additional sections proposed by myself (Manual of Conch. (2), vii), and the curious *Helix cepoides* of Lea, formerly classed in *Stylodonta*, but referred to *Cochlostyla* by Dr. v. Moellendorff, under the sectional name *Ptychostylus*. This name being preoccupied by Sandberger for a tertiary genus of *Melaniidæ*, a substitute must be chosen; we propose, therefore, to designate the group *Hypoptychus*; *H. cepoides* Lea being the type, and thus far the only known species.

Bahamas and Florida Keys. The fossil species described by Dr. W. H. Dall from Florida belong mainly to *Plagioptycha*..

Genus GLYPTOSTOMA Binney & Bland.

Genitalia: ♀ system having an appendicula or a dart-sack entering the vagina. Vas-deferens entering the penis at its middle.

Jaw very low, broadly arched, having about sixteen strong separated ribs. Dentition normal.

Shell depressed, broadly umbilicated, having a simple, thin, acute lip.

The single species known is *G. newberryanum* W. G. Binn., of San Diego, California. The shell is entirely Patuloid in form, but not in texture. Its systematic position is doubtful.

Genus ACANTHINULA Beck.

Said to possess a dart-sack and mucous glands, and probably to be grouped here.

Genus VALLONIA Risso.

This genus of minute shells probably belongs here. A dart-sack is present.

Group III, TELEOPHALLA.

Female genital system lacking all accessory organs; male organs complicated by the presence of a long flagellum and a well-developed appendix.

Jaw thin, delicately plaited or distantly striated (or smooth ?).

Besides the two genera given below, this group perhaps includes *Pararhytida* Ancey, an oxygnathous group.

Genus SAGDA Beck.

Genitalia: ♀ system without accessory organs; duct of the spermatheca long. Ova rather large, few in number, with calcareous shell. ♂ system having a long penis at the apex of which are inserted the retractor muscle, vas-deferens, and a long, folded flagellum; and at the middle of the penis is inserted a very long but simple flagellum-like appendix.[15]

The jaw is thin, delicate, arched, composed of narrow vertical plates soldered together. Dentition typically Helicoid. Foot long and narrow.

Distribution, Jamaica.

[15]See Pilsbry, Proc. A. N. S. P. 1892, p. 213, pl. 13.

Shell rather glassy, with many narrow whorls and thin, acute, outer lip.

Genus CYSTICOPSIS Mörch.

Man. of Conch. (2) v. p. 5. 7. Proc. A. N. S. P. 1892, p. 214, pl. 13.

Genitalia: ♀ system without dart-sack or mucous glands; duct of the spermatheca very long, having a diverticulum; uterus much distended, retaining the numerous young which are born living. ♂ system having a long flagellum upon the penis, and a glandular appendix which terminates in two long flagellum-like processes.

Jaw vertically striated. Teeth normal.

Shell thin, globose, the lip thin, acute, not expanded or reflexed.

Foot short, wide.

Distribution, Cuba and Jamaica.

Group IV, EPIPHALLOPHORA.

Genitalia: ♀ system without accessory organs; ♂ having the penis continued into an epiphallus which generally bears a flagellum.

Jaw smooth (oxygnath), or ribbed (odontognath).

The species of this group require much more investigation before we shall be in a position to correctly classify them. Most of the large, solid Helices of the tropics and the southern hemisphere belong here.

- Tropical American forms.
  - Caracolus.
- Forms of S. E. Asia, etc.
  - Camæna.
  - Camænella.
- Australo-Moluccan forms.
  - A feathery glandular appendix on penis.
    - Obba.
  - No appendix; epiphallus sometimes degenerate.
    - Chloritis.
    - Hadra.
    - Planispira.
    - Papuina.

Genus CARACOLUS (Montfort) Pilsbry.

Genitalia: ♀ system lacking accessory appendages; ♂ system having the retractor muscle and a long epiphallus inserted at the apex of the penis, the epiphallus continued as a short flagellum beyond the insertion of the vas-deferens. Duct of spermatheca long or short.

Jaw either smooth or stoutly ribbed; teeth normal.

Distribution, West Indies and Northern South America.

The following sections belong here: *Caracolus* s. s., *Lucerna*, *Dentellaria*, *Isomeria*, *Labyrinthus*, * * *Eurycratera*, *Parthena*, *Polydontes*, *Thelidomus*, *Liochila*, and probably *Cepolis*.

Genus CAMAENA (Alb.) Pils. & v. Moell.

Pilsbry, Manual of Conch. (2) VI, p. 197. Moellendorff, Nachrichtsbl. d. D. M. Ges. 1891, p. 195. Pilsbry, *l. c.* 1892, p. 71.

Genitalia: ♀ system having no accessory appendages; the vagina is bound to the wall of the body-cavity by a thin muscle band; duct of the spermatheca very long. ♂ system provided with a very muscular penis containing a penis-papilla, and continued above in an epiphallus and flagellum; retractor attached to the epiphallus.

Jaw ribbed.

Distribution, South-east Asia, Philippines, etc.

The specimen dissected by me was sent without the shell by Dr. v. Moellendorff.

As sections or subgenera of *Camœna* the following may be placed: *Camœna* s. s., *Pseudobba*, *Phœnicobius* and *Camœnella*.

Subgenus CAMÆNELLA Pilsbry.

Genitalia as in *Camœna*, but penis-papilla very large. Jaw ribbed. Marginal teeth of the radula wide, low, and multicuspid. Shell (see Manual of Conch. (2) VI, p. 239).

Type *Helix platyodon* Pfr.

See figure accompanying this paper. The specimens dissected were sent me by Dr. v. Moellendorff.

Genus OBBA Beck.

=*Obbina* Semper.

Genitalia: ♀ system without accessory organs; ♂ system having a flagellum and a feather-like glandular appendix.

Jaw smooth; teeth not peculiar.

Distribution, Philippines and some adjacent islands.

Genus CHLORITIS Beck.

Genitalia: ♀ system without accessory appendages; ♂ system having a long epiphallus inserted with the retractor muscle at the apex of the penis, and continued beyond the insertion of the vas-deferens as a flagellum.

Jaw stout, strongly ribbed; teeth not peculiar, the marginals tricuspid.

Hadra is very closely allied to *Chloritis* in anatomy and shell, and should probably be considered a subgenus. The groups *Papuina* and *Planispira* are also near to *Chloritis* in anatomical features, and if all were united the group would be about equivalent in value to the other groups herein called genera. A closer study of specimens may, however, show differences not known to me.

Contrary to the general rule, the presence or absence of a flagellum seems to be a character of very trifling import among the species of the group *Chloritis* + *Hadra* + *Papuina* + *Planispira*; the epiphallus also is lacking in some of the species, notably in *Cristigibba*. This is a case of degeneration, in all probability, comparable to the Fruticicoloid forms in which the vaginal appendages are lost, or to the section *Canistrum* of *Cochlostyla*.

The shells of some species of *Chloritis* are very like some of *Dorcasia*, but the anatomical characters very widely separate these two groups.

Subgenus HADRA Alb.

Genitalia scarcely differing from *Chloritis* except that the flagellum is frequently lacking. Jaw and teeth similar to those of *Chloritis*.

These, like the species of *Chloritis*, are ground snails.

Distribution, Australia.

This division I formerly considered a genus, but I agree with my friend Hedley who holds that it is scarcely separable from *Chloritis*.

Genus PAPUINA Martens.

Genitalia: ♀ system without accessory appendages; ♂ system usually having a flagellum upon the penis, but it is sometimes lacking. Jaw delicate, coarsely ribbed.

Differs from *Hadra* in the shell, the exclusively arboreal station, and the more delicate jaw.

Genus PLANISPIRA Beck.

Genitalia as in *Papuina*, the flagellum being present in typical *Planispira* (*zonaria*), absent in sect. *Cristigibba*.

Jaw smooth, ribless.

Differs from *Obba* in lacking the glandular appendix; from *Papuina*, *Hadra* and *Chloritis* in the smooth jaw; but it will prob-

ably be found to intergrade with *Chloritis* in characters when more species are known anatomically.

Group V, HAPLOGONA.

Genitalia entirely lacking accessory organs; penis without an epiphallus; jaw smooth (oxygnath), vertically striated (aulacognath), or flatly plaited (stegognath). Outer lateral teeth generally multicuspid. This group may be classified thus:

- Aulacognath or stegognath; shell with simple, sharp lip.
  - A mucous pore on the tail — *Endodonta.*
  - No mucous pore; aulacognathous.
    - *Patula.*
    - *Anoglypta.*
    - *Trochomorpha.*
- Odontognath; shell having reflexed or thickened lip.
  - *Polygyra.*
  - *Polygyrella.*
  - *? Praticolella.*

Genus POLYGYRA (Say) Pilsbry.

Proc. Acad N. S. Phila. 1889, p. 193.

Anchistoma, in part, of H. & A. Adams, Tryon, Fischer, *et al.*

The genital system lacks all accessory organs, there being no dart-sack, no mucous glands, no flagellum on penis; the duct of the spermatheca is short and simple, without an accessory blind sack.

The jaw is strongly ribbed, and there is no median projection on its cutting edge.

Oviparous, the eggs small, numerous.

Shell helicoid, varying from globose to lens-shaped or planorboid; horn-colored or brown, sometimes banded, the most constant band supra-peripheral; striated; lip flatly reflected; aperture teeth often wanting, but typically three—1 parietal, 2 upon the lip; axis perforated, umbilicus open or closed.

Distribution, North America. We have every reason to believe that this group has been in the past, as it now is, exclusively North American.[16]

Subdivisions.—The group is quite homogeneous, easy transitions being traceable between the various sections, through species which are quite intermediate. Sections: *Polygyra* s. str., *Dædalochila*, *Triodopsis*, *Mesodon*, *Stenotrema.*

In the "Nomencl. and Check-list of Amer. Land Shells" (1888) this genus was correctly defined, but several groups not agreeing with my diagnosis were included. These groups were subsequently

[16]See Pilsbry, Journal de Conchyliologie, Paris, 1891, p. 22.

eliminated by me (Proc. Acad. Nat. Sci. Phila., 1890, p. 299; The Nautilus, August, 1891, and Jour. de Conch. 1891, p. 22.) and the genus restricted to its present limits.

Genus ENDODONTA (Albers 1850) Pilsbry.

Shell patuloid, with or without folds or denticles within the aperture; generally horn-colored with radiating or zigzag reddish flames.

Animal having a more or less developed caudal mucous gland,[17] and supra-pedal furrows.

Genitalia unknown, but probably like *Patula*.

Jaw thin, delicately ribbed (stegognath) or striated. Central and lateral teeth as in *Patula*; marginal teeth low, wide, having one or several short cusps; rarely pseudo-zonitoid.

Distribution, Oceanica, New Zealand, Australia.

The elucidation of this group is involved in considerable confusion. Albers and other early authors give shell characters only, in defining their groups. Hutton first called attention to the anatomy of species related to *Endodonta*, and to the fact that certain of the New Zealand forms possessed a caudal slime-gland; and he founded a family "*Charopidæ*" on this peculiarity, characterizing numerous generic groups therein. Suter (Trans. N. Z. Institute, 1880–1892) made certain modifications, and considerably enlarged the limits of the family, the name of which he changed to "*Phenacohelicidæ*." The writer made some observations upon the systematic position of these groups in The Nautilus, Sept., 1892, and grouped all of the mucous-pore bearing genera under the generic name *Gerontia* Hutt. A month later proof-sheets of Mr. Charles Hedley's article upon *Charopidæ* were received at Philadelphia. This valuable paper contained a synopsis of all previous publications known to the author upon the subject, and the fact that *Endodonta, Pityo, Charopa*, etc., possess a mucous tail gland, like *Gerontia*, etc., was for the first time brought forward.

A brief review of Mr. Hedley's article appeared in The Nautilus for October, 1892. Mr. Hedley does not give the same limits to his *Charopidæ* that the writer gave to *Gerontia*; nor would it be expected, as our papers, his in Australia and my own in America,

[17] The credit of the discovery that the Patuloid forms (such as *Charopa* herein included possessed a caudal gland, rests with my friend Charles Hedley, of Sydney, N. S. W., whose observations both printed and in letters have influenced largely the limits here given to this group. My former views are shown in the "Observations on New Zealand Helices" in The Nautilus for Sept., 1892.

were written each in complete ignorance that the other was engaged upon the group in question.

The present genus, therefore, is the product of our independent labors, and is equivalent to *Charopidæ* Hedley *plus Gerontia* Pilsbry. It therefore includes *Phenacohelicidæ* Suter and *Charopidæ* Hutton.

The choice of the name *Endodonta* for the genus is inevitable, as it is the oldest proposed. The following groups seem to belong here:

Endodonta s. str. (+ *Pitys* Pse. *non* Beck).
Libera Garrett.
Diaglyptus Pils. (? ? = *Pitys* Beck, never defined).
Simplicaria Mouss. (= toothless *Endodonta*).
Maoriana Suter (*Huttonella* Suter, preoc.).
Æschrodomus Pils. (= *Thera* Hutt., preoc.).
Charopa Alb.
Gerontia Hutt.
Therasia Hutt.
Calymna Hutt, (*plus Amphidoxa* Hutt. *non* Alb.).
Pyrrha Hutt.
Phenacohelix Suter (= *Fruticicola* Hutt. *non* Held).
Allodiscus Pils. (= *Psyra* Hutt., preoc.).
Suteria Pils. (= *Patulopsis* Suter, *non* Strebel).
Thalassohelix Pils. (= *Thalassia* of N. Z. authors *non* Alb.; not *Thalassia* Chevrolat).
Phacussa Hutt.

Genus PATULA Held.

Genital system lacking all accessory appendages. Jaw vertically striated. Marginal teeth multicuspid.

This genus includes the typical forms of Europe and America (*Discus, Anguispira, Pyramidula, Gonyodiscus*), and also the subgenus *Helicodiscus* Morse. Perhaps *Zoogenites* Morse. Various forms of this genus are found in most parts of the world, except Oceanica, Australia, etc.

Genus TROCHOMORPHA.

Semper, Reisen im Archip. Phil., Landmoll.

Distinguished from *Patula*, etc., mainly by the keeled and otherwise very different shell and the differently shaped marginal teeth of the radula.

Genus ANOGLYPTA Martens.

Hedley, Proc. Linn. Soc. N. S. Wales (2), VI, p. 22, 1891.

Genitalia simple as in *Trochomorpha;* jaw and teeth also resembling that genus, from which this is sundered mainly on account of the peculiar shell.

Distribution, Tasmania.

Group VI, POLYPLACOGNATHA.

Genitalia lacking all accessory organs; jaw composed of numerous separate quadrangular plates; lateral teeth bicuspid.

Genus PUNCTUM Morse.

Genital system like *Patula.* Jaw composed of about 16–19 separate quadrate plates. Dentition: central teeth unidentate, laterals bidentate.

Shell discoidal, with round, crescentic aperture, and thin, acute lip.

Distribution, Holarctic realm.

Differs from *Microphysa,* etc., in having the plates of the jaw actually unsoldered, but connected by a delicate membrane.

Genus LAOMA (Gray) Pils.

Genital system unknown. Jaw composed of 20–24 quadrangular papillose plates. Central tooth unicuspid, side teeth all bicuspid.

Shell more or less trochiform, generally keeled and variegated; aperture rhomboidal, lip thin, simple.

Section *Laoma s. s.*, aperture with lamellæ within.

Section *Phrixgnathus* Hutton, aperture without lamellæ.

Distribution, New Zealand.

My knowledge of the anatomy of this genus is derived from the writings of Hutton and Suter. The jaw should be compared with that of *Phacussa, Therasia,* etc. The lateral and marginal teeth are peculiar and very characteristic.

Genera of Doubtful Position.

Genus STROBILOPS Pilsbry.

Strobila Morse 1864, not Sars 1833.
Strobilus Sandberger *et al.*, not Anton 1839.

Genitalia unknown. Jaw ribbed.

This genus is represented by many species in the middle and later tertiary of Europe, and by several living species in America,

extending south to Venezuela. It is therefore, like *Vallonia, Zonitoides, Pupilla,* etc., a genus of the Holarctic realm.

The New Zealand forms referred to *Strobila* have been separated under the name *Maoriana* by Mr. Suter. They are a modification of *Endodonta.*

Living Species.	European Tertiary Species.
S. labyrinthica Say.	*S. uniplicata* Al. Braun.
Var. *strebeli* C. & F.	*S. elasmodonta* Reuss.
Var. *virgo* Pils.	*S. diptyx* Boettg.
Var. *affinis* Pils.	*S. costata* Sandb.
Var. *morsei* Dall.	*S. labyrinthicula* Mich.
S. salvini Tristr.	*S. sublabyrinthica.*
S. hubbardi A. D. Br.	(Syn. *H. lautricensis* Noul.)
(Syn. *H. vendryesiana* Gloyne.)	*S. monile* Desh.
	S. pseudolabyrinthica Sandb.
	S. duvalii Mich.

Genus AMPELITA Beck.

Anatomy unknown.[18]

Genus PEDINOGYRA Alb.

Hedley, Proc. Roy. Soc. Queensl. 1889, and Proc. Linn. Soc. N. S. Wales, 1892.

This genus has characters of groups I and IV, with others allying it to *Panda.*

Genus POLYGYRATIA Gray.

Anatomy unknown.

Genus MACROCYCLIS Beck.

This group is still unknown anatomically. A single species, *M. laxata,* is known. It may belong to *Helix* s. str.

Genus SOLAROPSIS Beck.

Manual of Conchology (2), v, p. 177.

This genus rests, at present, wholly upon conchological characters.

[18] *A. xystera* has been dissected by the author since this paper was written. It presents peculiar characters which leave the position of the genus problematic.

THE EVOLUTION OF THE PREMOLAR TEETH IN THE MAMMALS.

BY W. B. SCOTT.

The mode of evolution of the mammalian molar tooth up to and from the tritubercular pattern, which has been elaborated by Cope (No. 1) and Osborn (No. 7) as well as the nomenclature proposed by the latter for the various cusps or elements which make up the crown of the mammalian molar, has been very generally accepted by morphologists. According to this view, the primitive form of tooth in both jaws is that exemplified by many reptiles, viz., a perfectly simple cone. The cusp which represents this primordial element throughout the various phyla of mammals is called the *protocone*. To this are added, as a second stage, small anterior and posterior cusps, called respectively the *para-* and *metacones*. This stage gives a crown composed of three cusps all in the same antero-posterior line and is exemplified by such genera as *Dromatherium* and *Triconodon*. The next step would appear to consist in a shifting of the relative position of the cusps, and now the molars of the two jaws, hitherto similar, begin to display an important difference. In the upper jaw the protocone begins to move inward or mesially, the para- and metacones remaining upon the external or lateral side of the crown, while in the lower jaw the protoconid remains upon the outer side of the tooth, the para- and metaconids shifting toward the inner side. In this stage the molar crowns have a triangular shape, the protocone forming the apex, and the para- and metacones the base; but while in the superior molar the apex is directed mesially, in the inferior tooth it is directed laterally. The next stage affects primarily the lower molars and depends upon the change from the primitive condition, in which the upper and lower molars merely pass each other with a shearing movement, or in which each tooth opposes merely one tooth in the opposite jaw, to the alternating condition, in which each lower molar opposes two upper ones, or opposes one and shears against another. The change consists in the addition to the primitive triangle of the tooth (trigonid) of a low heel or talon, which may subsequently divide into two cusps, of which the outer is called the hypoconid and the inner the entoconid. It may, however, be the case that the hypoconid is first developed and the entoconid subsequently added

were writ… Formosa. It is therefore, like *Vallonia*, *Zoni*-upon the … of the Holarctic realm.

The pre… referred to *Strobila* have been separated labors a… by Mr. Suter. They are a modification hey. It … Hutton.

The … it is the … here …

European Tertiary Species.
S. uniplicata Al. Braun.
S. elasmodonta Reuss.
S. diptyx Boettg.
S. costata Sandb.
S. labyrinthicula Mich.
S. sublabyrinthica. (Syn. *H. lautricensis* Noul.)
S. monile Desh.
S. pseudolabyrinthica Sandb.
S. duvalii Mich.

Endo… **ARPELITA** Beck.

Lib…

Dic…

Sim…

Mon…

X…

Ch…

Ge…

The…

Cal…

Pa…

Ph…

Ph…

Ar…

Sp… **PSEUDOGYRA** Alb.

… and Proc. Linn. Soc. N. S. Wales, 1892.

Ph… … groups I and IV, with others ally-

Ph…

… **POLYGYRATIA** Gray.

Li…

strict… **MACROCYCLIS** Beck.

Th… … anatomically. A single species, *M.* [*Di…* … belong to *Helix* s. str.

Hel…

of t… **SOLAROPSIS** Beck.

ion, … Geology (2), v, p. 177.

… … wholly upon conchological charac-

[Thi… … by the author since this paper was written. It wise … which leave the position of the genus problematic. of the …

generellen Begriff zusammenzufassen. Wie einleuchtend auch das logische Princip der systematischen Einheit für jene Vermuthung sprechen mag, so kann die Naturforschung doch nur dann der lockenden Aussicht folgen, wenn genügende Beweisgründe die Speculation zu stützen vermögen.

"Wie die Annahme eines ursprünglichen Kegelzahnes als Surrogat einer einstweilen fehlenden besseren Einsicht in den historischen Bildungsgang zu beurtheilen ist, so kann man sich auch die Umwandlung des triconodonten Zahnes in die trituberculäre Form nicht gut vorstellen. Man begreift zwar sehr leicht, dass dadurch den Thieren ein grosser Vortheil erwachsen sei, aber welche physiologischen Processe die Formänderung leiteten, ist jetzt noch gänzlich unklar. Cope und Osborn glauben, die beiden Seitenhöcker seien gegen den Protoconus verschoben worden. Das ist sicher die einfachste Hypothese; aber warum am oberen Molaren dieselben nach aussen, am unteren Backzahn nach innen gedreht worden seien, ist mir nicht klar geworden. Ferner habe ich von Osborn keinen Grund erfahren, der ihn berechtigt, die Höcker der oberen und unteren Zähne direct zu homologisiren. Wer bei Säugethieren verschiedener Ordnungen die Zähne der oberen und unteren Reihe genau betrachtet, wird häufig zu der Erkenntniss gelangen, dass die Seiten der Zähne einander im umgekehrten Sinne vergleichbar sind, d. h. dass der Innenseite eines oberen Molaren die Aussenseite des unteren und dem Vorderrande des oberen der Hinterrand des unteren Backzahnes entspreche. Diese Thatsache habe ich durch Mahn an den Molaren von *Arvicola* genauer besprechen lassen, ich habe mich auch an Vertretern anderer Gruppen von der Richtigkeit derselben überzeugt. Wenn man die eben geschilderte Lagebeziehung als allgemeines Gesetz für Säugerzähne betrachten darf, dann ist wohl die Annahme Osborn's über die Stellung der drei Koni an entgegenwirkenden Zähnen (bezogen auf dieselbe Sagittalebene) richtig; aber um ganz consequent zu denken, dürfte man nicht die am oberen und unteren Molaren nach vorne stehenden Höcker als Paraconus bez. als Paraconid bezeichnen, man muss vielmehr den Paraconus im Oberkiefer homolog dem Metakonid des Unterkiefers setzen." (No. 4, pp. 893–5.)

The paper of Mahn on the molars of *Arvicola*, referred to above, presents the following reasons for regarding the anterior end of the upper molar as equivalent to the posterior end of the lower:

to it. Between these two there generally appears a minute median cusp, the hypoconulid, which on the last molar may become a large element, necessitating the formation of an additional fang, but on the others seldom reaches considerable proportions. In very many forms the upper molars now add a fourth main cusp, the hypocone, at the postero-internal angle of the crown. In the tritubercular stage two small accessory elements are developed in the lines connecting the protocone with the para- and metacones, and are called respectively the proto- and metaconules. We have now arrived at a stage in which both the superior and inferior molars have six elements (quadritubercular stage of Cope) to which type the molars of nearly all the higher mammalia may be traced back, through successive stages of simplification.

To this scheme of molar development propounded by Cope and Osborn, the only serious objections hitherto made are those of Fleischmann (No. 4), who rejects both the nomenclature and the homologies explained above. Before proceeding to the question of the evolution of the premolars, it will be necessary to examine the views of Fleischmann, since any comparison between the two categories of teeth will, of course, depend upon the homologies of the molar cusps. "Wenn überhaupt eine Ableitung der Säugermolaren von einfacheren Formen möglich ist, so müssen die Ausgangsglieder bei Reptilien gesucht werden. Aber die theoretisch geforderten Zwischenformen sind uns nicht genügend bekannt, und die systematische Stellung der fossilen Thiere, deren Zähne nach Cope und Osborn die Bindeglieder der Reptilien-und Säugethierzähne darstellen, ist wegen schlechter palæontologischer Urkunden vollkommen in's Dunkle gehüllt. Deshalb ist der Versuch der beiden amerikanischen Forscher wohl als eine Hypothese zu achten, für welche die Wahrscheinlichkeit unserer modernen wissenschaftlichen Anschauungen spricht, jedoch fehlt ihm jeder exacte Beweis.

"Auch die Annahme, dass alle Glieder des ursprünglichen Säugethiergebisses ganz gleichartig entwickelt waren, scheint mir solange nicht nothwendig aus den jetzt bekannten Thatsachen abgeleitet werden zu müssen, als nicht die gesammte Organisation der Thierwelt der Puercozeit eine einigermaassen sichere Verknüpfung mit den lebenden Säugern gestattet. Bis jetzt ist die Annahme, alle Zähne müssen von einer gleichen einfachen Urform stammen, nur begründet in unserem Bestreben, die mannichfachen Verhältnisse der Thierwelt, wie es eben geht, unter *einen*

generellen Begriff zusammenzufassen. Wie einleuchtend auch das logische Princip der systematischen Einheit für jene Vermuthung sprechen mag, so kann die Naturforschung doch nur dann der lockenden Aussicht folgen, wenn genügende Beweisgründe die Speculation zu stützen vermögen.

"Wie die Annahme eines ursprünglichen Kegelzahnes als Surrogat einer einstweilen fehlenden besseren Einsicht in den historischen Bildungsgang zu beurtheilen ist, so kann man sich auch die Umwandlung des triconodonten Zahnes in die trituberculäre Form nicht gut vorstellen. Man begreift zwar sehr leicht, dass dadurch den Thieren ein grosser Vortheil erwachsen sei, aber welche physiologischen Processe die Formänderung leiteten, ist jetzt noch gänzlich unklar. Cope und Osborn glauben, die beiden Seitenhöcker seien gegen den Protoconus verschoben worden. Das ist sicher die einfachste Hypothese; aber warum am oberen Molaren dieselben nach aussen, am unteren Backzahn nach innen gedreht worden seien, ist mir nicht klar geworden. Ferner habe ich von Osborn keinen Grund erfahren, der ihn berechtigt, die Höcker der oberen und unteren Zähne direct zu homologisiren. Wer bei Säugethieren verschiedener Ordnungen die Zähne der oberen und unteren Reihe genau betrachtet, wird häufig zu der Erkenntniss gelangen, dass die Seiten der Zähne einander im umgekehrten Sinne vergleichbar sind, d. h. dass der Innenseite eines oberen Molaren die Aussenseite des unteren und dem Vorderrande des oberen der Hinterrand des unteren Backzahnes entspreche. Diese Thatsache habe ich durch Mahn an den Molaren von *Arvicola* genauer besprechen lassen, ich habe mich auch an Vertretern anderer Gruppen von der Richtigkeit derselben überzeugt. Wenn man die eben geschilderte Lagebeziehung als allgemeines Gesetz für Säugerzähne betrachten darf, dann ist wohl die Annahme Osborn's über die Stellung der drei Koni an entgegenwirkenden Zähnen (bezogen auf dieselbe Sagittalebene) richtig; aber um ganz consequent zu denken, dürfte man nicht die am oberen und unteren Molaren nach vorne stehenden Höcker als Paraconus bez. als Paraconid bezeichnen, man muss vielmehr den Paraconus im Oberkiefer homolog dem Metakonid des Unterkiefers setzen." (No. 4, pp. 893–5.)

The paper of Mahn on the molars of *Arvicola*, referred to above, presents the following reasons for regarding the anterior end of the upper molar as equivalent to the posterior end of the lower:

" Wenn man die Zähne im Ober- und Unterkiefer betrachtet, so springt sofort die Thatsache in die Augen, dass die mit einander artikulirenden Zähne nicht gleich gerichtet sind; denn im Unterkiefer stehen die spitzen Enden der Molaren nach vorn, im Oberkiefer sind sie nach hinten gerichtet, und das spitze Ende jedes Unterkieferzahnes trifft auf das breite Ende seines Antagonisten im Oberkiefer.

" Die drei Cementleisten liegen, wie bereits erwähnt, an verschiedenen Stellen jedes Zahnes, zwei am abgerundeten Ende an der facialen und lingualen Kante, eine am entgegengesetzten mehr spitzen Ende; das wiederholt sich an allen Gliedern des Gebisses. Also trifft die Seite des Zahnes, welche eine Cementleiste besitzt und im Unterkiefer nach vorn sieht, auf die Seite des Oberkieferzahnes, an der zwei bilateral gelegene Cementleisten stehen. Man muss deshalb, um bei der Formvergleichung der Zähne zu richtigen Ergebnissen zu gelangen, je eine Zahnreihe des Oberkiefers gegen die entgegengesetze Reihe im Unterkiefer um 180° drehen, dann fallen die spitzen und stumpfen Enden aller Molaren auf einander.

" Bei der morphologischen Vergleichung muss man desshalb das Vorderende eines Unterkiefermolaren mit dem Hinterende eines Oberkiefermolaren als entsprechend ansehen. Vergleicht man ferner die Form der einzelnen Zähne, so wird man den früheren Beobachtern beistimmen, welche die grosse Ähnlichkeit zwischen dem dritten hintersten Molaren des Oberkiefers und dem ersten vordersten Molaren im Unterkiefer hervorheben. M_2 ist in beiden Kiefern ziemlich gleichförmig, desshalb muss M_3 des Unterkiefers M_1 im Oberkiefer entsprechen. So lässt sich auf Grund der anatomischen Thatsachen zunächst für die schmelzfaltigen Zähne von *Arvicola* die Behauptung aufstellen, dass die Richtung der oberen und unteren Reihe gerade umgekehrt ist. Durch theoretische Betrachtung der Entwicklung der Zähne in einer Einstülpung des Hautzahn-Anlagen enthaltenden Ektoderms ist B. Dybowski zu der ähnlichen Auffassung gelangt, dass die Zähne des Ober- und Unterkiefers in der Richtung von rechts nach links um 180° gedreht seien, aber er hat seine Meinung durch Thatsachen nicht als zwingend erwiesen." (No. 5.)

From an examination of the dentition of certain marsupials, Fleischmann reaches conclusions opposed to those of Osborn and Cope, especially with regard to the history of the talon of the lower molars, and says of Osborn's view: "Die Betrachtung der von

mir gegebenen Figuren lässt eine solche Auffassung direct als hinfällig erscheinen."

To these criticisms it may be replied: (1) It is perfectly true that the present state of palæontological knowledge does not permit the construction of an undoubted phyletic series from the Triassic to the Puerco, but when the geological and the morphological succession agree so well, we are entitled to assume, in the absence of any evidence to the contrary, that the steps of the change are those indicated by the successive genera of mammals. Nobody has stated that these steps were of necessity those which the evidence at present available appears to show; on the contrary, Osborn has expressly pointed out another possible method.

(2) The relations of the "entire organization of the animal world of the Puerco times" to that of the present, are, it is true, far from clear, and yet the connection of many Puerco genera with their Wasatch successors is so obvious as to deprive this objection of any weight. The hypothesis that all the varieties of mammalian molars were derived from a single type of tooth is much more than a "seductive speculation." For many different groups it has such a high degree of probability as almost amounts to demonstration, for no group has it been shown to be untrue, and in those in which we cannot demonstrate its truth, the necessary phyletic series has not yet been discovered. On the other hand, the history of the premolars makes it evident that similar stages of dental evolution may be reached in different ways.

(3) It is no objection to the truth of a morphological fact that we cannot give a physiological explanation of it. Indeed, the factors of transformation form at present the most actively disputed questions of biology. But whether or not mechanical (or dynamical) factors of change are admitted as efficient causes of transformation, it is clear that they at least indirectly condition the result and that mechanically unfavorable changes cannot be perpetuated. It is not difficult, in a general way, to see why anisognathism and movements of the jaw other than vertical should necessitate the reversed arrangement of points upon the crowns of the upper and lower molars, because they are subjected to opposite strains. Even in the premolars, where the homologous cones are not reversed, the reversal of form is as clearly shown as in the molars, i. e. when the premolars reach a stage of complication comparable to that of the molars.

(4) The considerations which Dybowski (No. 3), Fleischmann and Mahn advance as showing that the anterior end of the lower molars is homologous with the posterior end of the upper ones and vice versa, are derived from the resemblance of form in these parts respectively and from the assumption that in *Arvicola* the cement bands on the teeth are guides to homology. But for purposes of morphological analysis, resemblance of form is of no value whatever, and as Mahn himself points out, the positions of the cement bands in *Arvicola* is determined by the necessity of fixing the tooth in the alveolus without undue compression of the cells of the persistently functional enamel organ. How deceptive mere resemblance of form may be, is clearly shown by the facts of premolar evolution already alluded to; viz., that in those genera which have molariform premolars, there is the same apparent correspondence between the outside of the upper and the inside of the lower premolars, as obtains in the molars. And yet, as will be more fully shown in the sequel, this correspondence is entirely of form and not of homology, for in both superior and inferior premolars the protocone remains upon the external or buccal side of the crown.

When the line of argument adopted by Fleischmann and Mahn is pushed to the conclusion that the third lower molar is the homologue of the first upper molar, it would certainly appear to be a *reductio ad absurdum* of the considerations which lead to such a result. On Mahn's principles the fourth upper premolar of *Castoroides*, and not the first molar, may be proved to be homologous with the last inferior molar. If the equivalence of $\underline{m_1}$ and $\overline{m^3}$ means anything at all, it must imply that at some time in the early history of the mammals, either the upper or lower series was turned about, end for end, m_1 now occupying the place originally held by m^3. Is such a thing conceivable? and if so, what are the steps by which the change was brought about? Such a shifting could not be effected by a partial rotation of the upper tooth in one direction and of the lower tooth in the opposite direction.

The only safe method of determining the homologies of the various cusps in the protean forms assumed by the mammalian molar and premolar, is that of following out step by step the changes which take place in well defined phyletic series. Even embryology, valuable as is the assistance which it affords, must be used with great caution and in a general rather than a special way. The shapes taken by embryonic teeth are seldom like anything which is known among fossil

forms, at least in matters of detail. For example, no one would infer from the ontogeny of the horse's molar, that it had been derived from such types of dentition as those displayed by *Hyracotherium*, *Anchitherium*, etc., and yet if any phyletic series may be regarded as well established, it is that of the *Equidæ*. Knowing the phylogeny, we are able to eliminate cenogenetic features and to show that the ontogeny in no way contradicts the results of palæontology.

(5) Fleischmann objects to Osborn's homologizing the cusps of the upper and lower molars. Strictly speaking, of course, an upper tooth is not homologous with the corresponding lower tooth, and nevertheless we speak very properly of the upper canine as equivalent to the lower, etc. In the *Triconodon* molar there is no reason why the anterior basal cusps of the upper molars should not be homologous with the anterior cusps of the lower molar in the same sense that the protocone is equivalent to the protoconid. All that Osborn's nomenclature implies is that in the tritubercular tooth a certain element represents the anterior cusps of the triconodont molar, and in no way denies the possibility that the primitive simple cones,(haplodont stage) are reversed in the two jaws. There is not a particle of evidence, however, for such a reversal in the haplodont stage, nor is any fact known which could suggest a rotation of the upper and lower molars in opposite directions, in stages subsequent to the triconodont. If the series of genera selected by Osborn really represents the stages of molar development, there is nothing like rotation, but merely a lateral displacement of the cusps.

(6) The conclusions which Fleischmann reaches from his examination of the marsupial dentition are quite inadmissible. Palæontological discovery seems every day to make it more clear, that the placental mammals are not derived from any marsupials as yet known, but that placentals and marsupials form two distinct and divergent series. The objection of uncertain phylogenetic relationship which Fleischmann urges against Osborn's series of genera applies with more force to any reasoning founded upon marsupial dentition. In particular, Fleischmann protests against the view that the talon of the lower molars is something superadded to the primitive triangle, and unrepresented in the triconodont tooth. But this objection leaves out of account the fact that the talon can be of importance only when the upper and lower molar series begin to

alternate, so that each lower molar opposes two upper ones; nor can the talon be functional until there is some displacement of the superior protocone and the tritubercular stage is reached, giving a cusp which the talon can oppose.

In *Triconodon* these conditions are not fulfilled. Following Fleischmann's line of reasoning, it might be shown that the posterior cusp of the cat's inferior sectorial was the "metamere" and equivalent to the talon, but such a conclusion would be entirely erroneous as it has been demonstrated that in the cats' molar the talon has disappeared. Furthermore, the history of premolar development proves that the talon may be superadded to the primitive triangle, and that the latter may be complete before the former makes its appearance. At all events, no conclusion as to such a problem can be safely drawn from the examination of teeth so far removed from the primitive condition as are those of *Dasyurus*.

The mode of origin of the trigonodont (or tritubercular) molar which has been suggested by Cope and Osborn will be assumed as correct in comparing the premolars with the molars, an assumption which is justified by the evidence at present available. In the absence of any well defined phyletic series of mammals from the Triassic to the Puerco, however, the theory cannot be regarded as finally established. The premolars have quite a different history, and, as I have elsewhere shown (No. 11, pp. 48-9) even when these teeth have become completely molariform, the elements which correspond in function and position to those of the molars, are not homologous with them, the key to these homologies being given by the position of the protocone.

The premolars do not display quite the same degree of constancy in the order of succession of their component cusps as do the molars. For this reason the fourth superior premolar will be taken as the standard. The primitive form of the premolar is a simple cone, implanted by a single fang, which is still preserved in several existing genera and which obviously corresponds to the protocone of the molars. As early as the Puerco, however, we find that P^4 in every known genus is complicated by the addition of a second cusp upon the inner or lingual side of the protocone, which may be called the deuterocone. This bicuspid tooth represents a pattern from which all the premolar types of the higher mammalia may be simply and naturally derived by the continued addition of new parts, which in many groups reach the same or an even greater degree of complication

than the true molars. Furthermore, this tooth brings out clearly the important fact that, while in the molar the protocone has shifted to the internal or lingual side of the crown, in the premolar it remains upon the external or buccal side of the crown, just as in the inferior molars. From this it follows that the deuterocone has no exact homologue in the molar crown, though functionally and in position, it corresponds to the protocone of the molar, and in the finished molariform premolar it occupies the antero-internal angle of the crown.

The relatively simple form of the fourth superior premolar which has been described, occurs almost universally in the genera of the Puerco Eocene, while the anterior premolars are, for the most part, as yet perfectly simple, consisting of the protocone only. In some genera, however, such as *Mioclænus*, $\underline{P^3}$ has likewise added a deuterocone. In the molars the new complications very generally make their first appearance upon the first of the series, and then successively upon the second and third, and so in the premolars $\underline{P^4}$ is the first to assume new features, and these then advance to the anterior premolars, the first never reaching the full molar pattern, even when the others have exceeded the molars in degree of complexity.

The second stage of premolar development consists in the addition of a second external cusp, posterior to the protocone, which I have called the tritocone, and which corresponds to the paracone of the molar crown (postero-external cusp), but it cannot be regarded as homologous with that element, because its position with reference to the protocone is entirely different. This stage of development imitates very closely the trigonodont molar, and very frequently this type of premolar displays the intermediate conules, either anterior, posterior, or both. In position these conules correspond to the proto- and metaconules of the molars, but are obviously not homologous with them. How very gradually this addition of the tritocone may be effected is beautifully shown in the series formed by placing together the different varieties and species of *Protogonia* and *Phenacodus*. Here the tritocone may be seen in all stages, from a very minute and scarcely visible cusp, and gradually enlarging until it reaches the size of the protocone (*Phenacodus*.) This trigonodont stage of the fourth upper premolar is very widely distributed in the middle and upper Eocene, occurring in nearly all perissodactyls and creodonts. With some special modifications it persists to the present time in the sectorial of the Carnivora, in

many Insectivora and in some forms of Artiodactyla (e. g. *Dicotyles.*) In many forms this pattern of tooth does not occur in advance of the fourth premolar, while in others the second and third gradually assume the same structure, as in most of the Eocene perissodactyles. Even in *Phenacodus* p^3 is trigonodont, while p^2 consists of the protocone only.

The final step in the conversion of the premolars to the molar pattern is given by the addition of a fourth main element at the postero-internal angle of the crown, the tetartocone, which thus corresponds in position to the hypocone of the molars. The incipient stages of this element may be observed in *Helaletes* (*Desmatotherium*) among the perissodactyls, and in *Agriochœrus* among the artiodactyls, where it occurs as a minute and variable cusp just posterior to and hardly separated from the deuterocone.

So far as I have been able to observe, the scheme of development of the premolar crown is quite constant, and for p^4 universally so, and the nomenclature which is proposed for the premolar cusps is intended to express their order of succession, as they appear in p^4. However, exceptions to this order of succession do occur in the anterior premolars. For example, in p^3 of *Procamelus*, the inner crescent, (which in p^4 is formed by the extension of the deuterocone in both directions,) is produced by crests from the anterior and posterior edges of the protocone, which have not yet come into contact with each other and thus leave a gap opposite the apex of the protocone. As we shall see later, the posterior ridge in this tooth probably represents the deuterocone. Again, in *Hyracotherium venticolum* p^2 consists of two cusps, the proto- and tritocones, which are in the same antero-posterior line and the deuterocone is little or not at all developed. Other exceptions might be cited.

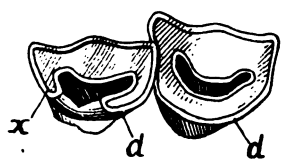


FIG. 1.

Procamelus occidentalis.

Third and fourth upper premolars of left side, *d* deuterocone; *x* additional anterior cusp. (After Leidy.)

The development of the inferior premolars appears to be somewhat less regular and constant than that of the superior. As in the upper jaw, the complication begins with $\overline{p}^4$ and advances anteriorly, but it is worthy of notice that in many forms the complication of the inferior premolars begins earlier and proceeds farther than in the

FIG. 2.

Hyracotherium venticolum.

Second upper premolar of left side, *pr.* protocone; *tr.* tritocone. (After Cope.)

case of the upper teeth. As before, the initial point must be taken as a simple conical cusp, the protoconid. Most of the existing unguiculates, as well as some recent and many extinct ungulates retain more or fewer teeth which depart but little from this type. In many forms the only addition to the protoconid consists in a small posterior basal cusp, which the analogy of such Mesozoic mammals as *Amphilestes and Triconodon* justifies us in regarding as the equivalent of the metaconid of the molars. In many of the Carnivora a second posterior cusp is added, to which, however, it is not necessary to give a name, since it is of little importance and occurs in but few forms. Frequently also an anterior basal cusp, strictly comparable to the paraconid of the molars, is added and a stage like that of the *Triconodon* molar is attained, consisting of elements which there is every reason to regard as homologous with the three primary cusps of the molars. There is, however, a great difference as to the regularity with which the para- and metaconids are present and in the order of their succession; one or the other of them may never appear at all, and while the metaconid is more frequently present and generally makes its appearance first, yet this is by no means invariably the case. Another difference from the molars consists in the ultimate fate of the metaconid in the molariform premolar, where it becomes either part or the whole of the talon and always remains on the same antero-posterior line with the protoconid, instead of shifting to the internal or lingual side of the latter. In the premolars, therefore, when a cusp occurs occupying the position taken by the metaconid in the molars, it cannot be regarded as homologous with that element, but rather with the deuterocone of the upper premolar and may consequently be called the deuteroconid. The latter element also varies as to the relative time of its appearance; sometimes it is the only element present in addition to the protoconid (e. g., *Pelycodus, Chriacus, Protogonia*) or it may be developed after either the para- or the metaconid, or it may appear last of all, and in very many cases it is altogether absent. Yet when it does appear, its homologies are perfectly obvious.

A fifth element is sometimes added to the premolar crown, posterior to the protoconid, and interior to the metaconid, thus occupying the position held by the entoconid of the molars. Clearly

however, it cannot be homologous with that element, its place with reference to the metaconid being entirely different. Its homologies are rather with the tetartocone of the upper premolar, as will appear when it is remembered that there is not that reversal in the position of the cusps of the inferior premolars compared with the superior ones which obtains between the upper and lower molars, the primary cusp or protocone remaining upon the external side of the crown in both upper and lower premolars. The tetartoconid is usually the last cusp to make its appearance upon the crown of the inferior premolar, but there are exceptions to this rule. For example, in *Triisodon* $\underline{p^4}$ consists of a very large protoconid and a lower but yet large heel or talon, made up of the metaconid upon the outside and the tetartoconid on the inside; neither para- nor deuteroconid is present.

In a former paper (No. 11, pp. 48-9) I gave a somewhat different account of the evolution of the lower premolar, in that I regarded the talon of the premolars as equivalent to that of the molars, and like it composed of hypo- and entoconids. This seemed to follow from the fact that the position of the cusps which make up the talon with reference to the protoconid is the same in both classes of teeth. An examination of a more extended series of premolars has, however, convinced me that the external element of the premolar talon is the equivalent of the metaconid and not the hypoconid of the molar. If this be true, the internal element obviously cannot be the entoconid, while its relation to the tetartocone of the superior premolar is the same as that of the deuteroconid to the deuterocone.

If the foregoing description be accepted as correct, it will appear that, while the inferior premolars may contain three elements which are homologous with molar cusps, the upper premolars contain but one cusp which can be homologized with a molar cusp, and, furthermore, that while in the molar crown the protocone is on the inner, and the protoconid on the outer side, in both sets of premolars, upper as well as lower, it retains its primitive position upon the external side.

The following table will serve to exhibit the correspondences of position (not of homology) between the molar and premolar elements when all are present.

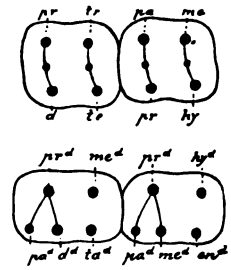


FIG. 3.

Diagram to exhibit the relations of the molar and premolar cusps, showing the fourth premolar and first molar of the left upper jaw and right lower jaw, *pr* protocone, *d* deuterocone, *tr* tritocone, *te* tetartocone, *pa* paracone, *me* metacone, *hy* hypocone, *prd* protoconid, *pad* paraconid, *med* metaconid, *tad* tetartoconid, *hyd* hypoconid, *end* entoconid.

UPPER JAW.			LOWER JAW.		
MOLAR.		PREMOLAR.	MOLAR.		PREMOLAR.
Protocone	=	Deuterocone	Protoconid	=	Protoconid
Paracone	=	Protocone	Paraconid	=	Paraconid
Metacone	=	Tritocone	Metaconid	=	Deuteroconid
Hypocone	=	Tetartocone	Hypoconid	=	Metaconid
			Entoconid	=	Tetartoconid

It now remains to consider the facts of premolar evolution as they are exhibited by the various orders of mammals. This is possible as yet for only a small number of groups, the palæontological evidence as to the others being too incomplete. The following orders will therefore be omitted; Monotremata, Marsupialia, Edentata, Tillodontia, Cetacea and Sirenia. In those orders which are taken into consideration, attention will be chiefly directed to the extinct forms.

I. PRIMATES.

In this order the Lemuroidea and the Mesodonta will be included for the sake of convenience, these groups all belonging to the same general series and characterized by great uniformity in the structure of the teeth.

The simplest type of premolar dentition in this series is presented by the Puerco genus *Mixodectes*. Of this form only the inferior teeth are known, and the premolars are remarkably simple; they consist merely of a high, acute and recurved protoconid with a rudimentary metaconid as a heel, which can hardly be called a

distinct element. In *Anaptomorphus* of the Wasatch and Bridger the lower premolars are as simple as in *Mixodectes*, but the upper ones have added a deuterocone, which is particularly well developed in P^4. The type of premolar structure which is most prevalent among the Eocene mesodonts is exemplified by *Hyopsodus*, a genus which is very abundantly represented in the Wasatch, Bridger and Uinta formations. In this genus the number of the premolars is still unreduced, being $\frac{4}{4}$; the anterior members of the series are of small size and perfectly simple, but the posterior two in each jaw have added new elements. In the upper jaw P_3 and $_4$ have a crown transversely placed, consisting of a trenchant pyramidal protocone and a smaller but well developed deuterocone. In the lower jaw $\bar{p}^3$ has in addition to the protoconid only a rudimentary metaconid, forming an inconspicuous heel; in $\bar{p}^4$ this heel is better developed, and on or at the internal side of the protoconid appears a small deuteroconid. In the existing representatives of the series, there is not very much advance upon the degree of premolar complication found among the Eocene mesodonts. In the lemurs there is the remarkable change first pointed out by Schlosser (No. 10) that the most anterior lower premolar has assumed the form and functions of the canine, but it bites behind the upper canine. In the higher primates the premolar type is that of the human "bicuspid," the crown consisting of two elements only, the protocone and deuterocone. The lower teeth do not exhibit the metaconid, which, as we have seen, is imperfectly developed in some of the Eocene forms.

II. CREODONTA.

In this group there is considerable divergence as to the amount and kind of premolar development. P 1, 2 and 3 in both jaws ordinarily remain quite simple, or at most complicated by the addition of a small posterior basal cusp in the inferior teeth, representing the metaconid. Sometimes, however, these teeth become very much more complicated, as in *Oxyæna* and *Palæonictis*, in which P_2 and $_3$ have large and well developed deuterocones, and in P_3 a tritocone is added so that this tooth becomes a reduced copy of the last premolar. Several other genera display a more or less prominent deuterocone on P_3, as for example *Deltatherium* and *Dissacus*, and in the lower jaw the metaconid may form a more or less prominent talon on p^3, as in the case in *Dissacus*, while in *Oxyæna* these cutting talons appear on all the inferior premolars

except the first, increasing in size as we pass from before backward and thus corresponding with the development of the deuterocone in the upper premolars. A very similar statement will apply to *Palæonictis*.

The fourth premolar in both jaws exhibits great variety among creodonts from a completely molariform to an extremely simple condition. Taking first the upper tooth, we find in such Puerco genera as *Oxyclænus* and *Deltatherium*, the simplest which occurs among the creodonts, viz., a compressed, acute protocone, with trenchant anterior and posterior edges and a conical deuterocone. From this stage several distinct lines may be traced in as many diverging directions. *Proviverra* agrees with *Deltatherium* in the construction of this tooth, but in *Sinopa* (*Stypolophus*) it is complicated by the addition of a small tritocone and in some species, of an anterior basal cusp, or protostyle, as well. *Sinopa* has thus reached a stage of development of P^4 in which all the elements of the carnivorous sectorial are present, and yet the small size of the tooth and especially the incomplete development of the tritocone render the term sectorial inappropriate to such a tooth. In some of the *Hyænodontidæ*, however, as *Oxyæna* for example, P^4 fully deserves to be called a sectorial, as the compressed protocone and enlarged trenchant tritocone form a very efficient cutting blade. But even here the main emphasis of development is on the first molar, which is larger and of more functional importance than the premolar. In this genus, P_3, also has all the elements of a sectorial. In *Hyænodon* itself, P^4, is reduced in size and importance, $\underline{m}^2$ being the largest and most efficient tooth in the series; the protocone is large, but the tritocone is insignificant, and the deuterocone so diminished that in some species it can hardly be said to exist as a separate element. *Palæonictis*, though obviously belonging to a phylum very distinct from that of the hyænodonts, closely resembles *Oxyæna* in the condition of the superior premolars.

The *Miacidæ* alone among creodonts have attained the carnivorous type of dentition. The superior sectorial is not, it is true more efficiently developed than in *Oxyæna*, but, on the other hand, the upper molars are tubercular, not sectorial at all. In *Didymictis* P^4 is quite like that of the viverrines, owing to the presence of a small, but very distinct anterior basal cusp.

A very different type of premolar tooth is that assumed by $\underline{P}^4$ in the *Mesonychidæ*. Though the same elements are present as in

Sinopa, their shape and mutual relations are altogether different. In *Dissacus*, the oldest genus of the family, this tooth has all the elements of the carnivorous sectorial, but the tritocone is added in the form of a conical tubercle, (which is considerably smaller than the protocone,) and not of a trenchant blade. In *Pachyæna* of the Wasatch and still more in the Bridger genus, *Mesonyx*, the gradual enlargement of the tritocone gives to the fourth premolar completely the pattern of the simple tritubercular molars.

Little is known with regard to the superior premolars of the *Arctocyonidæ*. In *Clœnodon* (*Mioclœnus*) *corrugatus*, and presumably also *Arctocyon*, $\underline{P_3}$ is a simple, compressed, conical tooth, supported by two fangs, and therefore without deuterocone. $\underline{P_4}$ has a very high and acute pyramidal protocone, on the anterior and posterior edges of which the cingulum is so elevated as almost to deserve the name of cusps. The tooth is implanted by three fangs and yet the deuterocone is very obscurely marked. If we may provisionally assign to this family the extraordinary and problematical genus, *Mioclœnus*, the systematic position of which is altogether doubtful, we may mention here the curiously thick, low, rounded and massive premolars, which characterize the genus. $\underline{P_4}$ has a very distinct deuterocone, and in $\underline{P_3}$ this element is more or less distinctly differentiated. These premolars are very much more like those of some of the *Periptychidæ* than they are like those of any known creodont.

FIG. 4.

Fourth lower premolars of the left side, internal aspect. 1, ? *Tricentes subtrigonus*; 2 ? *Clœnodon protogonioides*; 3 *Chriacus stenops*; 4 *Epichriacus schlosserianus*; 5 *Deltatherium fundaminis*. *prd* protoconid, *dd* deuteroconid, *pad* paraconid, *med* metaconid. (Cope collection.)

In the lower jaw p_4 generally has a heel, formed by the more or less enlarged metaconid, and thus differs from the anterior premolars merely in its greater size and more developed heel. The paraconid is rarely added, though it becomes of importance in the *Mesonychidæ*. In *Dissacus* the paraconid is very small, but distinctly shown on $\underline{p^3}$ and $_4$, which have the protoconid remarkably high and acute. In *Pachyæna* a similar condition may be observed

but the protoconid is relatively reduced, and the metaconid enlarged. In *Mesonyx* the paraconid makes its appearance on $\underline{p^3}$. No member of this family develops a deutero- or tetartoconid in the inferior premolars. In the *Mesonychidæ*, the lower premolars thus become molariform, but the resemblance between the two classes of teeth is due not only to the complication of the premolars but also to the simplification of the molars, in which the paraconid is reduced and the meta- and entoconids have altogether disappeared. The elements composing the crowns of the two categories of teeth are more nearly homologous than is usually the case, the proto- and paraconids being common to both, but the talons are not homologous, being formed in the premolars by the metaconid, and in the molars by the hypoconid.

In the *Triisodontidæ* p^4 has a distinct resemblance to the corresponding tooth in the *Mesonychidæ*, but the paraconid is not developed, and in *Triisodon* and *Sarcothraustes* the large, transversely directed heel is divided into two parts, the meta- and tetartoconids. In *Goniacodon* the latter element does not occur.

In *Arctocyon* and *Clænodon* p^4 is remarkable for its great relative size, but is very simply constructed, having in addition to the protoconid merely an obscurely developed metaconid. In *Tetraclænodon*, however, p^4 has all the elements of a molar, but the paraconid is very small, and the talon neither so high nor so complex as in the molars.

Chriacus (if we may assign that genus to the Creodonta) presents an entirely different type of p^4 from any which has been yet described in this group, and one which is much more characteristically mesodont than creodont. In this tooth the only element besides the protoconid which is present, is a small but perfectly distinct deuteroconid upon the lingual side of the crown. *Epichriacus* has in addition to this a very small paraconid. In *Deltatherium* the "primitive triangle" (a term which is applicable to the premolars only by analogy, as it is rarely attained and then only in advanced stages of differentiation) is almost as completely developed as in the molars. In addition, there is a rudimentary heel in the form of a very small metaconid, which, strange to say, has not kept pace with the development of the deuterocone of $\underline{p_3}$. Not including the *Mesonychidæ*, which belong in a somewhat different category, there are not less than three genera of creodonts, in which $\underline{\quad}$ attains more or less completely to the molar pattern, viz., *Epichria-*

cus, Deltatherium and *Tetraclœnodon.* The later genera of the *Proviverridæ* have exceedingly simple inferior premolars. In *Sinopa* $\overline{p^3}$ and $\overline{4}$ have very obscure metaconids, and in the latter there is an equally obscure paraconid.

In the *Hyœnodontidæ* $\overline{p^4}$ has only a more or less enlarged metaconid in addition to the protoconid. In *Oxyœna* the metaconid forms a large trenchant blade; in *Hyœnodon* the heel is much reduced, but the protoconid is greatly enlarged, so that, with the exception of the canine and $\overline{m^3}$, $\overline{p^4}$ is the largest tooth in the jaw. *Pterodon* resembles *Hyœnodon* in this respect. *Quercytherium,* clearly a member of this family, is remarkable for the massiveness of its inferior premolars, which almost rival those of *Mioclœnus.*

Palœonictis has very similar inferior premolars to those of *Oxyœna,* except for the much greater relative enlargement of $\overline{p^4}$. In the Bridger genus *Patriofelis* this enlargement is carried still further and at the same time the number of inferior premolars is reduced to three.

Didymictis is remarkable for the antero-posterior elongation of $\overline{p^3}$ and $\overline{4}$ which have small but very well marked para- and metaconids. In $\overline{p^4}$ the cingulum is raised on the hinder border of the tooth making a second posterior cusp behind the metaconid.

III. INSECTIVORA.

In many of the existing insectivores the premolars have undergone considerable modification, but unfortunately we can obtain but little assistance from palæontology in attempting to make out the steps of this modification. Among American genera of this order there is only one family which is at all well understood, viz., the *Leptictidæ* and in this group, strange to say, the oldest member yet discovered, exhibits the most complicated premolar structure. This genus, *Ictops*, has been found only in the Wind River beds at the base of the Bridger, and in the White River, though there can be no doubt that it existed in the intervening period. In *Ictops* the premolars show an unusual degree of complication for an unguiculate mammal. In the upper jaw P_1 is very small and implanted by a single fang. P_2 is likewise small but is carried by two fangs, and has a small tritocone, but no deuterocone. In P_3 the protocone is very high, and the tritocone, though distinct, is much smaller; there is also a well developed deuterocone, so that all the molar elements are present, though owing to the disproportionate size of the proto-

and tritocones, the tooth cannot be called molariform. P_4 is even more complicated than the molars. As in the latter the two external cusps are of equal size, and the deuterocone is much extended transversely, also a small tetartocone corresponding to the hypocone of the molars is present. In addition to these parts there is a small basal cusp at the antero-external angle of the crown which does not occur in the molars but which is found on P_4 of many creodonts and carnivores. In the lower jaw p_1 and $_2$, are small and simple, the former being carried by one root and the latter by two: this tooth is larger than the corresponding upper one. P_3 has added a small metaconid. P_4 is molariform, with the metaconid enlarged to a talon, and para- and deuteroconids added. This tooth is distinguished from a true molar only by the greater relative size of the protoconid. The White River species of this genus, *I. dakotensis*, differs from the more ancient one, with respect to the dentition, only in the fact that the deuterocone of P_3 is no longer a conical cusp, but transversely extended and crescentoid, the proto- and tritocones are also more nearly equal in size; in other words the tooth is now completely molariform, even to a rudiment of the tetartocone.

In the White River genus, *Mesodectes*, P_4 is molariform, but P_3 has no tritocone, the tooth consisting of a compressed and trenchant protocone, and internal to this a conical deuterocone. Cope calls these teeth P_4 and m_1 respectively, but this I think is a mistake. At all events the statement, that, "in *Leptictis* the last premolar is sectorial in form consisting of a single compressed longitudinal crest without internal tuberosity or cusp," is incorrect. (No. 2, p. 801.)

In the genus *Leptictis*, also from the White River beds, P_3 is without the deuterocone and resembles the anterior premolars in every respect, except that it is slightly larger. P_4 is molariform, and p_1 differs from that of *Ictops* in being inserted by two fangs. So far as we can judge at present, the series *Ictops*, *Mesodectes*, *Leptictis*, would appear to represent successive stages in the simplification of p_3. Doubtless the same is true of the lower premolars, but the mandibular dentition of *Mesodectes* and *Leptictis* is unknown.

Somewhat similar facts may be observed in comparing some of the extinct European insectivores with their nearest living allies. Thus Schlosser (No. 10. p. 117) regards the genus *Parasorex* as in some measure connecting the *Tupaiidæ* and the *Macroscelidæ*, but the extinct form has more complex premolars than either of the

recent families. In like manner *Amphidozotherium*, from the Oligocene, resembles the *Talpidæ* in molar structure, and is referred to that family, but it has more complex premolars than the existing moles.

The recent genus *Gymnura* agrees very well with *Leptictis* with regard to the condition of the premolars, the last one in each jaw having the elements of the molar crown.

IV. CARNIVORA.

In this group, the premolars never acquire any very great degree of complication. In the Pinnipedia the molars and premolars are very much alike, though this is due rather to a simplification of the molars than to any complexity in the premolars. These teeth may either be simple conical bodies, as in the *Otariidæ* and hooded seals (*Cystophora*), with a crown consisting of a simple cusp and implanted by a single fang; or, as in the typical *Phocidæ*, both classes of teeth are assimilated to one type, characterized by the suppression of the internal cusps, and the addition of sharp basal cusps on the anterior and posterior edges of the principal cone, which appears to represent the paracone in the upper molars, and the protocone in the premolars of both jaws and the lower molars. We are, however, as yet entirely ignorant of the phylogeny of the pinnipedes, and cannot therefore very well determine the homologies of these elements. The dentition of the creodont family, *Mesonychidæ*, presents many analogies to that of the true seals, but there can be no question of a genetic relationship between the two groups.

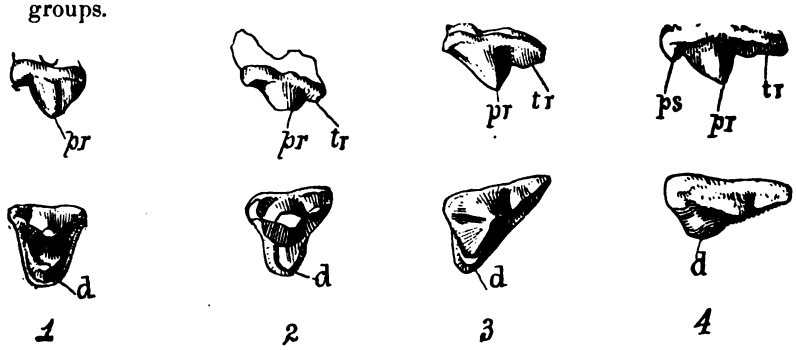


FIG. 5.

Fourth upper premolar of left side, external and crown views. 1, ***Deltatherium fundaminis***: 2, *Sinopa whitiæ*; 3, *Cynodictis gracilis*: 4, *Felis concolor*. *Pr* protocone, *d* deuterocone, *tr* tritocone, *ps* protostyle. (1 and 2 from the Cope collection.)

The premolars of the fissipede carnivores have a different history. In the upper jaw the anterior premolars are ordinarily composed of a compressed and more or less trenchant protocone, and on P_2 and $_3$ a small tritocone may also be added. According to Schlosser (No. 10 p. 265) the *Galecynus œningensis* of Owen is remarkable for the presence of anterior cusps upon these teeth. The fourth or sectorial premolar is constructed on essentially the same plan throughout the group, a plan which is already foreshadowed in many creodonts and fully attained in the *Miacidæ*. Typically this tooth consists of three elements, the proto-, deutero- and tritocones, the first and third of which are more or less compressed and trenchant and form the shearing blade. But there is much variation in regard to the relative size and shape of these elements, and consequently in the efficiency of the tooth as a sectorial weapon. In several groups a fourth element is added; viz., a cusp situated at the antero-external angle of the crown. This cusp, which appears to be homologous with the antero-external buttress or pillar of the perissodactyl premolar reaches its highest development in the cats, though in the earliest members of that group, the *Nimravidæ*, it is always small and sometimes rudimentary or absent (e. g. *Dinictis*.) The same element occurs in the viverrines, the hyænas, and the curious cynoid genus *Ælurodon* of the Loup Fork has it largely developed. The dentition of this genus presents some analogies with that of the hyænas, especially in the massiveness of the premolars. The same cusp also occurs in the creodont *Didymictis*. In the *Viverridæ* the deuterocone is unusually well developed, and in some of the genera is joined to the protocone by a sharp ridge running outward and backward. The hyænas display an unusual complication in that the outer wall of the sectorial consists of four cusps, an additional one occurring behind the tritocone.

The derivation of the bears from primitive dogs is now very generally admitted and the series of genera, *Amphicyon*, *Hemicyon*, *Hyænarctos* and *Ursus*, enables us to trace the successive modifications of the upper sectorial. In the first named genus, the upper sectorial is like that of a dog, but somewhat thickened; in *Hemicyon*, the tooth has become transversely extended and the deuterocone has shifted from the anterior edge to the middle line of the crown. In *Hyænarctos*, P_4 is reduced in relative size, and all the cusps are lower and more massive, and in *Ursus*, the same process is carried still further; the deuterocone has become almost atrophied, and the proto- and tritocones are so low and blunt that the tooth

no longer deserves the name of sectorial. Among the *Mustelidæ*, we find the upper sectorial very variously developed. In most cases it is constructed as in the dogs. In the otters the deuterocone is enormously expanded, both transversely and antero-posteriorly. In *Meles* the sectorial is small, but possesses a minute tetartocone, situated midway between the trito- and deuterocones, while in *Taxidea* the tooth is large, and the tetartocone acute and prominent and yet the crown does not lose its triangular shape.

In the *Procyonidæ* the upper sectorial has likewise become degraded to a tubercular condition, very similar to the construction of the molars, but even more complex. In *Procyon* there are three external cusps, the anterior accessory cone, the proto- and tritocones, the two latter of nearly equal height and conical shape. The inner side of the crown is nearly as long antero-posteriorly, as the outer, and is composed of two elements, the deutero- and tetartocones. In *Cercoleptes*, $\underline{P}_4$ is very similar to that of the viverrine genus *Arctictis* and is a quadrituberculate tooth of nearly square outline.

The lower premolars of the Carnivora are always more or less simple and trenchant, though they vary much in respect to thickness, height, acuteness, etc. They very generally display the metaconid, and sometimes an additional basal cusp is formed by the elevation of the cingulum posterior to the metaconid. The paraconid is seldom developed, but occurs in many of the viverrines; even the excessively microdont dentition of *Eupleres* exhibits it.

V. RODENTIA.

Our knowledge of the phylogeny of the rodents is so incomplete and fragmentary that little can be said with regard to the evolution of their premolars. The most striking fact about these teeth is the great reduction which they have undergone. In several genera they are altogether absent and in the great majority of species the formula is $\frac{1}{1}$ or $\frac{0}{0}$. The most ancient genus of rodents whose dentition is well known is *Plesiarctomys* which is found in all the American Eocenes above the Puerco and in the upper Eocene of Europe. In those animals the premolar formula and the construction of the crowns are like those of the squirrels, $\frac{2}{1}$. In the upper jaw, the first premolar ($\underline{P}^3$) is a rudimentary tooth, and the second ($\underline{P}^4$) is molariform; a tritubercular crown, consisting of two external cusps, the proto- and tritocones, and the deuterocone internally. It is interesting to observe that this construction of $\underline{P}^4$ corresponds closely to what we find in many insectivores and creodonts. The inferior premolar also has all the elements of a molar, though their relative

proportions are somewhat different; there is a high protoconid, a much smaller deuteroconid and a talon consisting of meta- and tetartoconids; the cusps are all connected around the periphery of the crown by crests which thus enclose a deep central concavity.

The teeth of later rodent genera often attain a very high degree of complication and when premolars are present they follow all the stages of molar evolution, at least in the case of the fourth pair, but materials are wanting to enable us to trace the steps of increasing complexity.

VI. CONDYLARTHRA.

In the family *Phenacodontidæ* some very instructive series may be observed. The superior dentition of *Protogonodon* (=*Mioclænus pentacus* Cope) is unknown, but in the lower jaw, the premolars, even the last one, are simple acute cones, but rudiments of a deuteroconid are observable in some specimens, now larger, now smaller. In *Protogonia* this element becomes enlarged and very distinctly separated from the protoconid, and at the same time a rudimentary metaconid makes its appearance. In *Phenacodus vortmani*, in addition to these elements, a paraconid is developed and the metaconid is elevated. In *P. primævus* a paraconid and a very small tetartoconid are added and $\bar{p}^3$ is now made more complex by the appearance of the deuteroconid, which is present in rudimentary form, even on $\bar{p}^3$. A similar series may be made out in the upper jaw. $\bar{P}^3$ is simple in *Protogonia* and contains only the protocone, while $\bar{P}^4$ has added the deuterocone. In *Phenacodus vortmani*, $\bar{P}^4$ has also acquired the tritocone, and besides this we find the antero-intermediate cusp, or conule, analogous to and occupying the same relative position as the protoconule of the molars, though obviously not homologous with that element. The occurrence of the conules is one of especial interest, as tending to show that the premolar

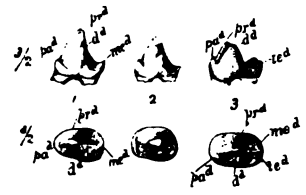


FIG. 6.

Fourth lower premolar of right side, internal aspect. 1 and 2 of *Protogonodon pentacus*, 3 of *Protogonia pliciferao prd* protoconid, *pad* paraconid, *med* metaconid, *dd* deuteroconid. (Cope collection.)

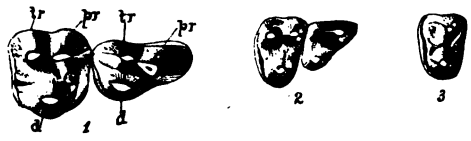


FIG. 7.

Upper premolars of Condylarthra, right side. 1, p^3 and ^{4} of *Phenacodus primævus*, 2, of *P. vortmani*, 3, p^4 of *Protogonia subquadrata*, *pr*, protocone, *d*, deuterocone, *tr*, tritocone. (After Cope).

crests in the perissodactyls, where they attain such a high development, arise, as in the molars, from the extension of the intermediate cusps and their coalescence with the internal and external cones. P^3 in this species is also tritubercular, but the deutero- and tritocones are very obscurely marked and the tooth is very much smaller than p^4. *P. primævus* differs from *P. vortmani* in the increased size and quadrate shape of p^4, and in the much more distinctly separated elements of p^3.

The *Periptychidæ* have less complex premolars than the preceding family. In *Periptychus* itself the superior premolars, except the first, have deuterocones, which have become crescentoid and thus remotely suggest the corresponding teeth of the true ruminants. The composition of the lower premolars is not altogether clear, but $p_{2 \text{ and } 3}$ appear to have merely a rudimentary crest-like heel, while p_4 has a deuteroconid, a rudimentary paraconid and a heel which consists of meta- and tetartoconids. This tooth, therefore, contains all the molar elements, but still it cannot be called molariform on account of the slight elevation of the heel. *Hemithlæus* has very simple premolars. $P^{3 \text{ and } 4}$ consist of the proto- and deuterocones only. In the lower jaw the first and second premolars have only the protoconid with no accessory lobes whatever; the composition of $p^{3 \text{ and } 4}$ is not known. The different species of *Anisonchus* display an advancing degree of premolar complication. In *A. gillianus* p^2 is a simple massive cone, while $p^{3 \text{ and } 4}$ have well developed deuterocones. P^2 has a thick protoconid and very small para- and metaconids, which are hardly more than elevations of the cingulum. In p^4 the metaconid is elevated into a considerable heel. The first and second upper premolars of *A. sectorius* are not known, but in $p^{3 \text{ and } 4}$ the deuterocones have become much enlarged and form crescent-like ridges and minute rudiments of the tritocone may also be detected. In the lower jaw $p_{2, 3 \text{ and } 4}$ have the para- and metaconids well differentiated. In *A. corniferus* all of the superior premolars are implanted by three fangs, and though it is not certain that p^1 possesses a deuterocone, all the others clearly have it. At the same time not even p^4 has developed a tritocone. The superior premolars of *Haploconus* are known only for two species, *H. lineatus* and *H. entoconus* and both agree in the simplicity of all except p^4, which has the usual deuterocone, but in the former species this element forms a crescent, and in the latter a conical tubercle. The lower premolars have metaconid heels of varying degrees of development

in the different species, but no deuteroconid; in *H. xiphodon* and *H. lineatus* the talon (metaconid) of $\underline{p^3}$ and $\underline{4}$, is separated by a median depression into long external and internal ridges, a tendency which also appears in many primitive artiodactyls.

In all the members of the *Periptychidæ* there is a more or less decided tendency for the premolars to become very massive and in many species they are distinctly larger than the molars.

VII. HYRACOIDEA.

The discovery, recently announced by Professor Marsh (No. 6), of the foot-structure of *Meniscotherium* justifies, in my opinion, the removal of that genus and family from the Condylarthra to the Hyracoidea. *Meniscotherium*, low as is its place in the geological scale, already exhibits a considerable degree of premolar complication and although we cannot assert that it is the ancestor of *Procavia* (*Hyrax*, see Oldfield Thomas, No. 13), yet it will suffice to show the stages of dental evolution. $\underline{P^1}$ is small and simple, implanted by a single fang; $\underline{p^2}$ has a similar but somewhat larger crown, and is inserted by two roots. $\underline{P^3}$ has a deuterocone of more or less crescentic pattern, while $\underline{p^4}$ is almost molariform. The proto- and tritocones are of nearly equal size, are compressed and so joined together as to make a wall. The deuterocone is a large conical tubercle, and the anterior and posterior conules are present, thus forming a tooth which has almost exactly the same construction as $\underline{m^3}$ which lacks the hypocone, as $\underline{p^4}$ does the tetartocone. There is some variation in the construction of this tooth, in the presence or absence of a ridge upon the external wall of the crown, marking the separation between the proto- and tritocones, and also in the condition of the cingulum.

In the lower jaw the premolars are very small and simple. $\overline{P^2}$ has a minute heel and the fangs are fused together. $\overline{P^3}$ is similar, but slightly larger. $\overline{P^4}$ is molariform and consists of two crescents, the composition of which is as follows: the protoconid sends a curved crest inward and forward to what may or may not be the paraconid, and a straight crest inwardly to the deuteroconid; the posterior crescent is likewise formed by two ridges which pass from the metaconid to the tetarto- and deuteroconids respectively.

In *Procavia* (*Hyrax*) the premolars have all assumed a molar pattern and the lophodont condition is more completely attained, though in the unworn tooth the separate elements may still be made out, which show that the premolars are constructed essentially like the hindermost of the series in *Meniscotherium*.

VIII. PERISSODACTYLA.

A very high degree of premolar differentiation is characteristic of this group. In all of the existing families these teeth have assumed the molar pattern, a tendency which very early becomes apparent in the ancestral forms, and even the extinct phyla, such as the *Hyracodontidæ*, *Palæotheriidæ*, *Titanotheriidæ*, etc., run through the same course.

The Wasatch perissodactyls have all advanced beyond the *Phenacodontidæ* which are contemporary with them, so far as dental evolution is concerned. In *Systemodon* the only one of the superior premolar series which is without additions to the protocone is the first, and even in that there is a faint anterior thickening of the cingulum, which represents the pillar or buttress, so conspicuous on the other premolars. $\underline{P^2}$ has quite a large deuterocone and a rudimentary tritocone which is barely separated from the protocone; the anterior pillar is slightly better developed than on $\underline{p^1}$. Seen from the external or buccal side, $\underline{p^3}$ and $\underline{^4}$ resemble the molars, having proto- and tritocones of nearly equal size, and the anterior pillar largely developed; internally, however, there is only one cusp, the deuterocone, which sends out two crests toward the outer wall of the tooth. These crests appear to be developed from conules analogous to those of the molars, and in $\underline{p^3}$ the posterior conule is not connected with either the deutero- or the tritocone.

The inferior premolars vary somewhat in the different species of the genus. In *S. semihians* $\overline{p^3}$ is very simple, having added only a small metaconid to the compressed and acute protoconid. $\overline{P^4}$ has also two internal cusps, the deuteroconid in front and tetartoconid behind. The number of cusps present is thus the same as in the molars, but the small size of the internal elements and the low heel give to the crown a very different appearance. In *S. tapirinus* $\overline{p^4}$ consists of two crescent-shaped cusps, the proto- and metaconids, of which the former rises considerably higher than the latter, but the tooth possesses no internal elements at all. $\overline{P^3}$ has a similar crescent-shaped metaconid, but the protoconid is compressed and pointed.

The genus *Isectolophus*, which continues this series through the Bridger and Uinta formations, does not present any modifications in premolar structure which require special description.

In the White River form *Mesotapirus* the last upper premolar has assumed the molar pattern by the addition of a tetartocone and in the lower jaw $\overline{p^3}$ and $\overline{^4}$ have the same number of elements as the

molar crowns, but in their appearance they differ from those teeth, owing to the much greater prominence of the protoconid.

The existing representative of this line is the tapir which, like the other recent families of the group, has all the premolars, except the first, in both jaws of the molar type. This is brought about merely by the addition of the tetartocone in the upper teeth, and by the elevation of the heel in the lower ones.

In the rhinoceros series essentially the same steps may be observed. The most ancient known member of the series, though perhaps not in the direct line of descent, is the Wasatch *Heptodon*, in which the last three upper premolars are composed of the same elements differing only in size and in the degree of separation of the tritocone from the protocone. In all of these teeth, the deuterocone, with its anterior and posterior crests, is present, and in all there is a well marked anterior buttress, formed by the elevation of the cingulum, and which on $\underline{p}_4$ is as large as in the molars. P^1 is extremely small. In the lower jaw $\overline{p}^1$ appears to be wanting, and the others increase in size and complexity posteriorly. $\overline{P}^4$ has an anterior crest, composed of the proto- and deuteroconids, and a basin-shaped heel, of which the outer and inner cusps are only obscurely indicated. This tooth is, therefore, nearly molariform. In $\overline{p}^3$ the deuteroconid is present, but not at all prominent, and does not form a crest with the protoconid, and the heel is still smaller and lower than on $\overline{p}^4$.

The superior premolars of the Bridger genus *Hyrachyus*, are essentially the same as those of *Heptodon*, as are also the inferior series, except that $\overline{p}^4$ has approximated somewhat more closely to the molar condition, owing to the greater elevation of the heel. *Helaletes* (*Desmatotherium*), however, though contemporary with *Hyrachyus*, exhibits an important advance in the appearance of the tetartocone on $\underline{p}_3$ and $\underline{\ }_4$ as a very minute cusp, hardly separated from the deuterocone. In the Uinta form *Amynodon* the separation of the deutero- and tetartocones is complete, but the crests, and especially the posterior one, are very low. Even in *Aceratherium*, the White River rhinoceros, the deutero- and tetartocones are much more closely approximated than are the analogous cusps of the molars (proto- and hypocones), and in advanced stages of wear the premolars present a somewhat different appearance from the molars, seeming to have but one internal element, in which both anterior and posterior transverse crests unite. In the lower jaw the trans-

formation is more complete, $\overline{p^3 - 4}$ being altogether like the molars, though, as we have seen, the elements were already present in *Hyrachyus*.

In the later genera of the rhinoceros line, such as *Aphelops*, *Rhinocerus*, etc., the last three premolars in both jaws are hardly to be distinguished from molars. It will be unnecessary to describe the evolution of the premolars in the *Triplopus-Hyracodon* series, as in them essentially the same stages may be noted.

Turning now to the *Titanotherium* line, we find a very similar order of events. The most ancient genus which can be referred to this series is the Wasatch *Lambdotherium*, in which $\underline{p_2 \text{ and } 3}$ are trigonodont, consisting of proto-, deutero- and tritocones, with a more or less clearly defined anterior conule. One important difference, however, between the upper premolars and molars should be noted, viz., that in the former the external cusps are convex, more or less strongly, on the outer side, while the external cusps of the molars are deeply concave on the outer side, and thus form V-shaped crests. In the lower jaw $\overline{p^2}$ is very simple; it consists of a high, acute protoconid, a well developed metaconid and an anterior basal elevation which may represent a rudimentary paraconid. On $\overline{p^3}$ the metaconid is enlarged and a minute deuteroconid makes its appearance upon the internal or lingual side of the protoconid. $\overline{p^4}$ is almost molariform; the proto- and deuteroconids form a crest and a very low and inconspicuous tetartoconid is added. However, neither the anterior nor the posterior V characteristic of the molars is complete, owing to the rudimentary character of both the para- and tetartoconids.

The Bridger genera, *Palæosyops* and *Telmatherium*, aside from their larger size, have premolars very much like those of *Lambdotherium*, only the fourth inferior premolar has the V-shaped crests better developed through the elevation of the para- and tetartoconids. In *Telmatherium* this elevation has proceeded so far that the tooth may fairly be called molariform. In the upper jaw we observe the same striking difference between the convex external lobes of the premolars and the deeply concave ones of the molars. Another change is the reduction or suppression of the conules in both classes of teeth.

This series is represented in the Uinta beds by *Diplacodon*, in which p_4 has become like the molars through the addition of the

tetartocone and the corresponding tooth in the lower jaw is completely so.

The line ends with the extraordinary genus, *Titanotherium*, of the lower White River horizon, in which $p_{2, 3}$ and $_4$ have added the second internal cusp and thus become molariform, though the difference in the form of the external cusps becomes even more marked than in the older genera of the series, for, although those of the premolars have become somewhat flattened, those of the molars have become excessively concave and are separated by a very prominent fold of enamel which projects much more strongly than in *Palæosyops*. Another difference between the two classes of teeth is the much smaller size of the premolars. In the lower jaw, also, $p_{2, 3}$ and $_4$ have become molariform, in a way that is unnecessary to describe, since it is the same as that already given in the case of $\bar{p}^4$ for *Lambdotherium* and *Telmatherium*.

IX. ARTIODACTYLA.

The members of this group never attain the high degree of homodontism which is characteristic of all the later perissodactyls, and yet they display a considerable amount of premolar complication and one which is brought about in very different ways in the different groups of the order, there not being the same uniformity in the steps of differentiation which we have found among the perissodactyls.

The most primitive type of artiodactyl dentition is that of *Pantolestes*, of the Wasatch, a genus, the true systematic position of which was made clear only by the discovery of its foot-structure. Previously it had been referred to the mesodonts and creodonts. In *Pantolestes brachystomus*, the only species in which the feet are known, p_1 and $_2$ have not been found, but p_3 and $_4$ agree in structure, having one external and one internal cusp, the proto- and deutero-cones respectively. The lower premolars are extremely simple. $\bar{p}^{2-4}$ are elongated in the antero-posterior direction and have compressed, trenchant crowns, which are made up of the large protoconid, with minute but distinct and sharp para- and metaconids.

From the *Pantolestes* type of dentition many divergent lines may be traced. We may begin our examination with the *Oreodontidæ*, an extremely peculiar American family, of which the most ancient member known is the Uinta genus, *Protoreodon*. Here the upper premolars are very simple, having a [illegible]tocone with

trenchant edges; a deuterocone is clearly marked only on P_4, where it has become crescentic in shape, while P_2 and $_3$ have trihedral crowns, but no distinct internal element. In the lower jaw $\overline{p}^1$ has become much elevated and pointed, and has taken on the form and function of a canine, the true canine having gone over to the incisor series, as in the true ruminants. This disposition of $\overline{p}^1$ is highly characteristic of the family. The other premolars ($\overline{p}^{2-4}$) have neither para- nor metaconids, but compressed, trenchant and acute protoconids, upon the inner side of which low ridges inclose two shallow fossæ, one anterior and the other posterior. It is difficult to homologize these ridges with the elements which we have described in the premolars of other groups. The later oreodonts are divided into two very distinct lines, the *Agriochœrinæ* and the *Oreodontinæ*. In the former subfamily the White River genus *Agriochœrus* displays an unusual degree of premolar complication for an artiodactyl. In the upper series the anterior three teeth are very simple and the external surface of the protocone is convex or flattened, but P_3 has a small deuterocone which is somewhat back of the middle. P_4 is almost molariform; the tritocone is somewhat smaller than the protocone and both are concave on the outer side, though somewhat less so than the molars. The tetartocone is a mere rudiment. In the lower jaw $\overline{p}^1$ is, as in the other members of the family, like a canine in form and function; $\overline{p}^2$ and $\overline{3}$ are simple compressed cones, while $\overline{p}^4$ has all the elements of a molar and consists of two pairs of crescents; the anterior pair is made up of the proto- and deuteroconids, and the posterior pair of the meta- and tetartoconids. In one respect, however, this tooth is different from a molar, in that the deuteroconid retains its conical shape and in consequence the anterior valley opens inward in front of it, whereas, in the molar the metaconid, which occupies an analogous position, is compressed and flattened and by its extension forward encloses the valley completely. $\overline{P}^4$ of *Agriochœrus* is much like the curious molars of *Lophiomeryx*.

In the *Oreodontinæ* the premolars develop in somewhat different fashion. P_4 is like that of the true ruminants and has a single pair of crescents, the deuterocone having a completely crescentic shape. The anterior premolars, when seen from the outside, appear to be perfectly simple and trenchant, but the inner side of the crown has a number of ridges disposed as loops and festoons, and which seem to stand in no very definite relation to the premolar elements here-

tofore described, though in position they correspond to the crescentic ridges which in p_4 run from the deuterocone to the anterior and posterior edges of the protocone. The posterior crest is best developed and on p_3 is especially prominent. In the lower series p_1 is enlarged, simple and caniniform; p_2 and $_3$ are smaller and have compressed, pyramidal protoconids, from the apex of which an oblique ridge descends internally, ending in an exceedingly minute deuteroconid; a small talon is present on p_2. The last premolar has the deuteroconid much increased and almost equalling the protoconid in height; the low talon consists of the metaconid and a very small tetartoconid.

The genera *Merychyus* and *Merycochœrus* closely resemble *Oreodon* in the character of their dentition, but have made some advances in the structure of the premolars. Thus in p_3 and $_4$ the internal crescentic ridges have almost united and so, when somewhat worn, present an appearance not unlike that of p_4. On p_2 the deuteroconid is more distinct and on p_1 it is separated from the protoconid by a wider interval, producing a pattern quite like that seen in the lower premolars of early members of the true ruminant line.

Leptauchenia exhibits again a different order of events. P_1 is very small and simple; on P_3 and $_4$ the anterior crescentic ridge has disappeared, while the posterior one is somewhat extended and thus the crown of the tooth is invaded by a deep narrow valley which runs backward and outward from the antero-internal angle. The inferior premolars are simplified and reduced in size; only p_4 displays a distinct deuteroconid and heel. *Cyclopidius* and *Pithecistes* exaggerate the peculiarities of skull structure shown in *Leptauchenia* and it may be presumed that the same is true of their dental characters, but the valleys are obliterated so early in these teeth that I can state nothing further than the very obvious fact of a great reduction in size of the premolars.

In the tylopodan series the premolars of *Leptotragulus* are not sufficiently well known to detain us, and we may, therefore, commence our survey with the White River genus, *Poebrotherium*. In this form P_1 has a simple and trenchant crown, which is remarkable for its fore and aft extension. P_2 and $_3$ are of the same general character, but are even more elongated (antero-posteriorly) and p_3 sometimes exhibits the posterior internal crescentic ridge, though this is variable. P_4 is of the ordinary selenodont pattern, composed of crescentic proto-

and deuterocones. P^1 has a small and simple crown. The other premolars are greatly extended antero-posteriorly and are greatly compressed; on p^3 and ^{4} the deuteroconid is represented by a ridge which descends from the inner side of the apex of the protoconid, which is obscurely indicated on p^3 but distinct on p^4. All the premolars except the first have paraconids.

In *Procamelus*, of the Loup Fork, the first and second upper premolars are small and simple, in the third an internal crescent is almost completed by the extension of the anterior and posterior internal ridges, which have not quite coalesced, and leave a small gap opposite the apex of the protocone. P_4 is of the typical ruminant pattern and resembles that of *Poebrotherium*. The most peculiar stage of premolar reduction in the cameline series is, however, that displayed by the Pliocene genera, *Holomeniscus* and *Eschatius*, which have lost all the premolars, except the fourth, of each series. In the former genus P_4 is of the ordinary pattern, composed of an external crescent, the protocone, and the crescentic deuterocone, while in *Eschatius* this tooth is reduced to a simple cone through the suppression of the internal element.

In the Tragulina the premolars remain very simple and trenchant, with small and sharp anterior and posterior basal cusps, though P_4 is of the typical ruminant pattern. The curious little White River genus *Leptomeryx* (if I do not err in referring it to this group), is remarkable for the complexity of its premolars. P_2 and $_3$ have elongated and acute protocones with trenchant margins and well developed conical deuterocones, and on P_3 a small ridge passes from the anterior edge of this element to the outer side of the crown, enclosing a small valley. In *Tragulus* the deuterocone is the merest rudiment and it should be added that specimens of *Leptomeryx* occur with premolars as simple as those of the recent genus. The lower premolars of *Leptomeryx* are also more complex than in *Tragulus*. P^1 is very small and simple and is isolated by a diastema both before and behind it; the succeeding teeth have acute and trenchant protoconids, to which is added on p^2 a metaconid, and on p^3 and ^{4} both para- and metaconids. On the latter the deuteroconid is represented by a thin crest which runs back from the apex of the protoconid parallel to its posterior margin and enclosing a deep valley; an indication of the same structure, but not nearly so marked, is visible on p^3.

The main facts of premolar evolution among the Pecora will be sufficiently explained by a consideration of the series *Dichobune*, *Gelocus*, *Prodremotherium* and *Palæomeryx*, without taking into account the numerous small variations which occur among the recent forms. *Dichobune* displays no important advance over *Pantolestes* in the structure of the upper premolars, but the last lower one ($\bar{p}^4$) has, in addition to the proto-, para- and metaconids a distinct tubercular deuteroconid. *Gelocus*, although a typical ruminant and much nearer to the modern types than *Dichobune* in almost every particular of structure, has, nevertheless, made no noteworthy advance over that genus as regards the character of the premolars. In *Prodremotherium* P_3 has completed the internal crescent, but it is important to notice that the deuterocone is eccentric in position and much nearer to the posterior margin of the crown than the anterior. P_2 has a rudimentary deuterocone. In the lower jaw p^4 has, when seen from the outer side, a trilobate appearance, the proto-, para- and metaconids being all present; in addition to these there is a well marked deuteroconid and a less distinct tetartoconid which are connected by very short transverse ridges with the external cusps which stand opposite to them. On $\bar{p}^3$ and $\bar{3}$ these internal elements are indicated only by faintly marked ridges. *Palæomeryx* has all the upper premolars of the same pattern, the inner crescent being now completed on the most anterior tooth (P_2) and the deuterocone having assumed a symmetrical position on P_3. The inferior premolars are like those of *Prodremotherium*, except that on $\bar{p}^3$ and $\bar{4}$ the internal cusps and transverse ridges are much better developed and the enclosed valleys deeper; $\bar{p}^2$ is somewhat reduced. From this condition that of the lower teeth in the various recent families may readily be traced.

It would not be worth while to describe the numberless minor variations of the premolars which occur in the various genera of extinct selenodonts contained in the families of the anoplotheres, anthracotheres, xiphodonts, etc. It will suffice to mention some of the more salient peculiarities. In the problematical little *Hypisodus* of the White River, the inferior incisors, canines and first two premolars form a continuous series of twelve subequal teeth. *Xiphodontherium* has lost the first lower premolar and $\bar{p}^2$ has become caniniform.

In *Rhagatherium* P_4 is molariform and has five cusps, the anterior conule being present in addition to the four main elements. $\bar{P}^4$ is exceptional in being like its predecessor in the milk dentition;

the paraconid is enlarged nearly to the size of the protoconid and on the inner side a conical cusp is added, the tooth thus consisting of three pairs of cusps. A similar $p^{\bar{4}}$ occurs in *Dichodon*.

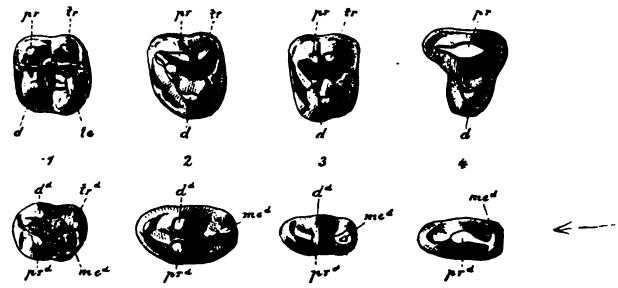


FIG. 8.

Fourth upper and lower premolars of left side. 1, *Dicotyles torquatus*; 2, *Thinohyus lentus*; 3, *Perchœrus probus*; 4, *Pantolestes brachystomus*. Letters as in the preceding figures.

Among the Suina the peccaries offer the most interesting series. The White River and John Day forerunners of that group, *Perchœrus* and *Thinohyus*, have extremely simple premolars; $\underline{P_4}$ consists of proto- and deuterocones only, and in $p^{\bar{4}}$ the only addition is the low and broad metaconid. In *Dicotyles* the last premolars are nearly or quite like the molars. In $\underline{P_4}$ the tritocone is first added and then the tetartocone, the latter not always occurring, even in the recent species. In $p^{\bar{4}}$ the order of events is similar, first the deuteroconid is added and then the tetartoconid, the latter element and the metaconid being at the same time more or less elevated. The curious *Listriodon*, a true pig, exhibits a similar condition; $\underline{P_4}$ has developed a tritocone, equal in size to the protocone, and $\underline{P_3}$ has a large deuterocone. On the other hand, $p^{\bar{4}}$ has added only the deuteroconid, the talon consisting only of the metaconid.

It might seem at first sight that many artiodactyls presented an important divergence from the normal scheme of premolar evolution in the way in which the inner crescent of the anterior upper teeth is developed, viz., by the coalescence of anterior and posterior ridges. This is seen in *Procamelus*, several of the *Oreodontidæ*, in some specimens of *Palæomeryx*, and other forms. But, on the other hand, a careful comparison of the various series will show that the departure from the ordinary course of development is not so radical as it seems. The posterior crest undoubtedly rep-

resents the deuterocone and the only difference, therefore, consists in the fact that the anterior horn of the inner crest is not developed from the deuterocone, as in p_4, but from the front margin of the protocone or from the cingulum.

X. AMBLYPODA.

The oldest representative of this group is the Puerco genus *Pantolambda*, in which the premolars have already attained quite an advanced stage of differentiation. Except in p_1 the superior premolars consist of a crescentic and acute protocone which projects strongly toward the inner side of the tooth, and a crescentic deuterocone. Seen from the outside, the last three inferior premolars seem to be simple, compressed and trenchant cones with metaconids which become better marked as we pass from p_2 to p_4. But in reality p_4 supports a complete anterior V and a broad transverse talon; the V is less developed on p_3 and very obscurely indicated on p_2. The superior premolars of *Coryphodon* show no advance upon those of *Pantolambda*. The lower premolars are in general like those of the Puerco genus, but the species vary in the completeness with which the cusps are distinguished. In *Bathmodon radians* the protoconid is concave externally and shows a distinct cusp on its *outer* side.

In the Dinocerata the homologies of the cusps in both the molar and premolar series are exceedingly obscure, owing not only to their own peculiarities, which are very marked, but also to the lack of any intermediate links by which to connect them with more typical forms of teeth. It will, therefore, suffice to say that in this group, with the exception of *Bathyopsis*, the first premolar in both jaws has disappeared and that the remaining teeth in this series have assumed the molar pattern. The crown is traversed by two ridges which meet internally and thus form a V which opens outwardly. Strange to say, this arrangement obtains in both upper and lower teeth, the usual reversal of pattern not being found.

XI. PROBOSCIDEA.

The phylogeny of the elephants is still an unsolved problem and we therefore know little as to the homologies of their molar cusps. From several facts, however, we may infer that their molar teeth were derived from a quadritubercular form. This condition is retained in the premolars of *Mastodon*, upper and lower alike. In *Dinothe-*

rium the cusps have united to form a pair of transverse crests, but a reminiscence of the tubercular stage is preserved in p_3. In this tooth the posterior crest is complete, formed by the junction of the trito- and tetartocones, but the anterior crest is unfinished, the deuterocone remaining isolated from the protocone.

The foregoing brief survey of the steps of premolar development in those mammalian groups which enable us to follow it out, shows very clearly that the premolars follow an order of differentiation quite at variance with that attributed to the molars, even when the final results are the same. It also shows that in the fourth upper premolar the order of succession in the appearance of the cusps is remarkably constant, while in the other superior premolars and in all of the lower ones, the order is very much less regular. But even in these cases the homologies are clearly given by the position of the new elements with reference to the primary cusp or protocone. Some of the Artiodactyla, however (e. g., *Procamelus*), appear to depart altogether from the typical order, in that the inner crescent of p_2 or p_3 (or both) is formed, not by the extension of a single element, the deuterocone, but by the coalesence of two. Even in these cases, however, we found reason to believe that the departure from the normal was less radical than at first sight seemed to be true, for the posterior element of the crest is with great probability to be homologized with the deuterocone. Another result which follows from our survey of premolar development, is the steadiness with which it is followed out when once undertaken. The cusps do not appear hap-hazard, or in a tentative way, but definitely may be traced from the faintest beginnings to the final result. It is obvious, further, that the same result may be independently attained many times in widely separated groups, and by precisely similar steps. Nothing could be more eloquent of the danger of constructing phylogenies from the teeth alone. Often, it is true, they would turn out to be right, but not infrequently they would lead to the grossest error.

The Milk Dentition.

Palæontology is not fitted to throw very much light upon the relation of the milk molars to the permanent set, i. e., with regard to the homologies of the cusps, for it is exceedingly difficult to obtain phylogenetic series of the temporary dentition. Some facts may, however, be gleaned which are not altogether devoid of value.

Thus, the genesis of the third upper milk molar (d_3) in the *Oreodontidæ* shows that in that tooth, at least, the order of succession of the cusps is different from that which occurs in the premolars, but on the other hand, the homologies of these cusps, as determined by their position, is the same as in the premolars. In *Oreodon* $\underline{d}_3$ consists of three cusps, of which the anterior one is extended and trenchant and obviously corresponds to the protocone of the premolars; posterior to this are two smaller crescentic cusps, the outer one of which is plainly the tritocone and the inner one the tetartocone. In *Merychyus* this tooth is rendered molariform by the addition of the antero-internal crescent, or deuterocone. The order of succession of the cusps thus appears to be: proto-, trito-, tetarto- and deuterocones, and is, therefore, different from that which is typical of the premolars, though, as we have already seen, there are variations in the order of development in the different teeth of the premolar series. For example, in *Hyracotherium* $\underline{p}^2$ consists of the proto- and tritocones only.

Some light is thrown upon the homologies of the elements of the characteristic six-lobed last lower milk molar of the artiodactyls by the curious and problematical little genus *Nanohyus*. Not that this genus is of any phylogenetic significance for the artiodactyls, and indeed its systematic position is quite uncertain; nevertheless, it exhibits $\bar{d}^4$ in a very interesting and instructive stage. This tooth is thus described by Leidy: "Its crown presents the usual greater breadth than the succeeding pair of those of the teeth behind as in pachyderms. The crown is trilobate, externally and internally, and this condition probably corresponds with three constituent pairs of lobes, the distinction of which is, for the most part, obliterated by wearing. The median division of the crown is largest and that in advance is the smallest. The abraded summit of the former presents an irregularly transverse quadrate surface of exposed dentine, continuous with a smaller subreniform tract upon the anterior division. The posterior division of the crown still exhibits the distinction of a transverse pair of lobes, of which the outer one is much the larger." In this tooth the homologies of the elements are obvious; the median pair of cusps are the proto- and deuteroconids respectively, and the posterior pair the meta- and tetartoconids, while the paraconid and a cusp, as yet not named, internal to it, form the anterior pair. In *Nanohyus*, therefore, $\bar{d}^4$ f
typical artiodactyl tooth merely in the relative

cusps, which in the latter are all of nearly equal size. This interpretation confirms Rütimeyer's view that d^4 in the artiodactyls represents a molar with a pair of cusps added to it in front and that the posterior pair do not correspond to the talon of m^3.

So far as they go, therefore, the facts of palæontology indicate that in the milk teeth the homologies of the cusps agree with those of the premolars rather than those of the molars.

The foregoing paper had been nearly completed before I received the valuable and interesting articles of Taeker (No. 12) and Röse (No. 8), in which the problem of the homologies of the molar and premolar cusps is investigated from the embryological standpoint. Taeker has confined his attention to the milk molars and finds that the homologies of the cusps in these teeth agree with those of the permanent premolars, so far as these homologies are determined by position. Taeker had not seen my notes on the premolars and attempts to homologize the milk teeth cusps with those of the true molars, but with the result that the paracone is always the first element to appear. I have shown that this element is really the protocone and consequently the palæontological and embryological results are in exact accord. Further, Taeker shows that the order of succession of the cusps in $\underline{d_3}$ in the recent artiodactyls is the same as we have found it to be in the *Oreodontidæ*, viz.: proto-, trito-, tetarto- and deuterocones. Again there is an exact correspondence in the results as to the characteristic d^4 of the artiodactyls, except that Taeker gives the name of paraconid to both of the anterior cusps. Needless to say, this cannot be correct, though it is not worth while to coin a special term for the antero-internal cusp.

Röse's investigation brings out the very unexpected fact that in their embryological development the true molars agree with the premolars and the milk teeth, and that in them also the first element to appear is the antero-external cusp, which in the upper molars has hitherto been considered the paracone, but which Röse believes to be the protocone. The evidence offered is not altogether conclusive and is open to a different explanation, but should Röse's view prove to be correct, it would follow that the molar and premolar cusps are really homologous after all, and the nomenclature which I have proposed for the latter would be superfluous, while the names now

given to the molar cusps would necessarily be transposed. Space forbids, however, a consideration of this question here. In one important respect Röse's views are altogether irreconcilable with the facts of palæontology, viz., in supposing that complex mammalian molars are formed by the coalescence of simple teeth. The series of genera which appear in successive horizons, and which we may confidently assume to stand in ancestral relations to one another, display the entire history of the complex premolars and show that new elements are formed by outgrowth from the old and not by coalescence. Such a series as that of the horses, for example, is sufficient to demonstrate this, unless we are prepared to assume that the apparent connection of the different members of the series is entirely illusory.

Summary.

1. Assuming the correctness of Osborn's results as to the homologies of the molar cusps, those of the premolars are differently arranged. In the upper premolars the protocone forms the antero-external cusp.

2. Additions to the protocone are typically made in the following order: (a) the antero-internal cusp—deuterocone; (b) postero-external cusp—tritocone; (c) postero-internal cusp—tetartocone.

3. In the lower premolars the protoconid takes the same position as in the lower molars, as does also the paraconid, but the metaconid forms the external cusp of the talon. The places of the meta- and hypoconids of the molars are taken by two corresponding but not homologous elements, the deutero- and tetartoconids respectively.

4. While there is no reason to doubt the homologies of the premolar cusps throughout the series, the order in which they make their appearance is by no means invariable, especially in the anterior teeth.

5. In certain selenodont artiodactyls (e. g., *Procamelus*, *Oreodontidæ*) the inner crescent of the anterior upper premolars is not formed entirely by the extension of the deuterocone, but by the coalescence of two ridges, one of which extends from the anterior and the other from the posterior margin of the crown.

6. The homologies of the cusps in the milk molars agree with those of the premolar elements, but appear to be even more irregular as to the order in which those cusps are developed. Thus, in $\frac{d_2}{}$

in the artiodactyls the order is proto-, trito-, tetarto- and deutero-cones. D^4 in the same group has a cusp internal to the paracone, which seldom appears in other types.

7. So far as the homologies of the cusps in the premolars and milk molars are concerned, the results of palæontology agree exactly with those of embryology.

List of Papers Quoted.

1. Cope, E. D. The Origin of the Fittest. New York, 1887.
2. Cope, E. D. Tertiary Vertebrata. Washington, 1884.
3. Dybowski, B. Studien über die Säugethierzähne. Verh. d. k. k. Zool.-botanisch. Ges. Wien, 1889, p. 3.
4. Fleischmann, A. Die Grundform der Backzähne bei Säugethieren. Sitzungsberichte d. kön. preuss. Akad. d. Wissenschaften zu Berlin, 1891, p. 891.
5. Mahn, R. Bau und Entwicklung d. Molaren bei Mus und Arvicola. Morphologisches Jahrbuch, Bd. XVI, p. 652.
6. Marsh, O. C. A New Order of Extinct Eocene Mammalia. Amer. Journ. of Sci. and Arts, 3rd Ser., Vol. XLIII, p. 445.
7. Osborn, H. F. The Evolution of the Mammalian Molar to and from the Tritubercular Type. Amer. Naturalist, 1888, p. 1067.
8. Röse, G. Ueb. d. Entstehung und Formabänderung d. menschlichen Molaren. Anatom. Anzeiger, 1892, Nr. 13 and 14.
9. Rütimeyer, L. Beitr. zu einer natürl. Gesch. d. Hirsche. Abh. d. schweiz. pal. Gesellschaft, Bd. X.
10. Schlosser, M. Die Affen, Lemuren, etc., d. Europ. Tertiärs.
11. Scott, W. B. The Osteology of Poebrotherium. Journ. of Morphology, Vol. V, p. 1.
12. Taeker, J. Zur Kenntniss d. Odontogenese bei Ungulaten. Dorpat, 1892.
13. Thomas, O. On the Species of Hyracoidea. Proc. Zool. Soc. London, 1892, p. 50.

DECEMBER 6.

The President, GENERAL ISAAC J. WISTAR, in the chair.

Fifty-eight persons present.

Papers under the following titles were presented for publication:—

"Notes on Monarda fistulosa." By Thomas Meehan.

"The Phenomenon of Fertilization in the Flowers of Monarda fistulosa." By Ida A. Keller.

The supposed South Chester Valley Hill Fault.—Mr. THEO. D. RAND remarked that in the Final Report of the Second Geological Survey of Pennsylvania, p. 174, the following occurs: "In Montgomery County the North Valley Hill belt of quartzite undoubtedly continues beneath the Schuylkill, on the same nearly east course, nearly to the Bucks County line . . . . runs on six miles into Moreland township. Here it ends, spooning to a point, and then sweeping round the east spoon point of the lime-stone . . . it returns westward as the south border of the limestone to the Schuylkill, at Conshohocken;" and on the same page in a foot note:

"Here the South Valley Hill begins and runs west into Lancaster County. We should, of course, suppose that this southern barrier of the synclinal limestone valley would be made by the quartzite. But it is made of hydromica slate. Repeated reports have been made during the last fifty years of the discovery of the quartzite ('Potsdam sandstone') at various points along the South Valley Hill; and no doubt specimens of quartzite have been picked up, and even thin outcrops of thin quartzite beds among the slates have been seen. But these amount to nothing. They cannot be accepted as expressing with any certainty the reappearance of the North Valley Hill belt on the South Valley Hill side of the limestone. It looks as if the North Valley Hill rocks descend against a great fault, running along the foot of the South Valley Hill, and are there entirely cut off by it, probably thrown by it (in company with the lower limestone beds,) high into the air on the Delaware side of the fault.

"Now it is just at Conshohocken that the Schuylkill River breaks out of the Chester County Limestone Valley to find its way to the sea, viz., in the short interval between the east end of the hydromica belt of the South Valley Hill coming from the west, and the west end of the southern quartzite outcrop coming from the east. What does this mean? Surely it is an added proof of a great fault; and of the total difference of the two formations; and of the futility of all endeavors to discover a southerly synclinal rise of the quartzite along the South Valley Hill."

If for Conshohocken in the text, Spring Mill, a mile and a half below Conshohocken, be read, the facts stated agree with these observations, but with the statements in the foot note these observations do not at all accord.

1, The South Valley Hill does not end at Conshohocken; on the contrary it extends eastward nearly three miles, as correctly represented on Mr. Hall's map in Report, Vol. C⁵ and apparently ends in a spoon above the limestone, as in turn does the latter above the Cambrian sandstone and the Cambrian above the Laurentian. This is about a half mile nearly north of Marble Hall; the exposures are many and clear, and the ending is in a very conspicuous hill which commands an extended view westward.

2, The southern quartzite does not end at the Schuylkill. As this has been repeatedly stated in the reports of the survey, and as in this last report, the non-existence of the Cambrian south of the limestone, west of the Schuylkill, is reiterated, in spite of proof heretofore adduced before the Geological and Mineralogical Section of the Academy, he would ask attention to the specimens on the table, from various localities within the area in which the Cambrian sandstone is recognized, and also from the "thin outcrops" which "amount to nothing" along a line, the direct lineal continuation of the Barren Hill-Spring Mill outcrops, and at distances from the Schuylkill of respectively:—Gulf 1½; County Line 2; Stackers 2½; Hare's 2¾; Fenimore's 3½; Wayne 4 miles southwest of the river.

This line is directly south of a line of limestone outcrops, precisely as is that east of the Schuylkill.

It is true that the exposures are scattered and the stratum narrow, but, except the specimen from northwest of West Chester, there can be no doubt that the rock is in place, and as to its absolute identity, no one who examines the specimens can be in doubt. That the belt is narrowing westwardly is shown by a comparison of the Barren Hill with the Spring Mill outcrop, besides which he believed that the schists of Cream Valley belong to the same horizon, resembling as they do those occurring between the Cambrian sandstone of the North Valley Hill and the limestone of the Chester Valley. These schists are colored on Dr. Frazer's map in C⁴ as azoic schists, etc., the same color is given the Laurentian north of the Cambrian, though he could not believe that this was Dr. Frazer's intention. In one of the areas thus colored, the great quarries northwest of Pomeroy have been opened, whence much stone has been obtained for recent work in Philadelphia by the Pennsylvania Railroad. This rock is the typical Cambrian sandstone of the region. There were specimens of it and of the schists on the table.

The limestone referred to as flanking the Cambrian west of the Schuylkill, and on its north side, occupies the floor of the narrow valley, locally known as Cream Valley, deep, with steep slopes near

the Schuylkill, but, from the rising of its floor, almost obliterated beyond Wayne. The limestone is narrow and rarely visible west of West Conshohocken, but at points distant respectively as follows: Gulf 1½; Stacker's 2½; and Pechin's 3 miles from the Schuylkill it appears in place, beyond which occasional sink-holes indicate its underlying. Northwest of West Chester it once more appears accompanied by the same schists as form much of the floor of Cream Valley, and which can be followed the whole distance.

Beyond this, and in almost the same line outcrops are numerous, accompanied by the same rocks until we reach the great outcrops near Doe Run in middle Chester Co., where, again, the existence of the Cambrian south of the limestone is universally admitted.

He could not, therefore, admit the futility of all endeavors to discover a southerly synclinal rise of the quartzite along the South Valley Hill, but would submit that if in a lineal distance of about thirty miles, section lines be drawn a mile apart, and more than one-half of these show an orderly succession from the outside to the center, while the others show in part the same with the remainder concealed by surface soil, the evidence of a simple synclinal is incontrovertible. It is only by the assumption that rocks, which anyone who seeks may find, do not exist, that the necessity of a fault becomes apparent. It is true that the sandy mica schists, at times garnetiferous, present a difficulty, but if these be divorced from the South Valley Hill hydromica schists with which they have no connection, and be regarded as a part of the Cambrian, and the Limestone, also Cambrian, as Walcott's recent discoveries seem to indicate, the objection vanishes. It is certainly true that in Chester County the limestones are both underlaid and overlaid with schists and gneisses, among which, close to, but not in contact with the limestone, so far as he had seen, occurs at numerous localities the characteristic Cambrian Sandstone with its micaceous parting, its rhomboidal jointing and its minute and usually disjointed tourmalines. One of the most remarkable facts is the wonderful uniformity of this rock from numerous and widely scattered outcrops over an area of more than fifty miles in length, and ten miles in greatest breadth. Indeed so exactly alike is the rock that it is impossible to determine the locality by inspection of the specimens. The specimens shown to-night verify this.

DECEMBER 13.

The President, GENERAL ISAAC J. WISTAR, in the chair.

Thirty-one persons present.

A paper entitled "The Principle of the Conservation of Energy in Biological Evolution, a Reclamation and Critique," by John A. Ryder, was presented for publication.

MR. JOS. WILLCOX read a paper entitled "A Theory of the Origin and Development of the Earth and Heavenly Bodies." (No abstract presented for publication.)

DECEMBER 20.

The President, GENERAL ISAAC J. WISTAR, in the chair.

One hundred and nineteen persons present.

Papers under the following titles were presented for publication:—

"The Birds of British Columbia and Washington, observed during the Spring and Summer of 1892." By Samuel N. Rhoads.

"Extra Morainic Drift of the Susquehanna, Lehigh and Delaware Valleys." By G. Frederick Wright.

PROF. G. F. WRIGHT made a communication, illustrated by lantern slides, on the evidence of the existence of paleolithic man in America. (No abstract presented for publication.)

DECEMBER 27.

The President, GENERAL ISAAC J. WISTAR, in the chair.

Two hundred and forty-one persons present.

The following were ordered to be printed:—

NOTES ON MONARDA FISTULOSA.

BY THOMAS MEEHAN.

As stated in the class-books, *Monarda fistulosa* is a variable species. A plant in my garden, originally from a shaded woodland in Eastern Pennsylvania, blooms from midsummer continuously till frost.

The midsummer heads are terminal. At the base of the common peduncle is a pair of leaves with two axillary buds. These make branches, and the earliest capitulum of the season stands regularly in the fork made by these branches.

But as these secondary branches grow and form pairs of opposite leaves, only one of the axillary buds in the lower pair pushes into growth. This one grows with so much vigor, that the capitulum is pushed to one side, the common peduncle becomes lateral, and the axillary branch becomes the leading stem.

At the next node the same behavior prevails, but at the third node both axillary buds develop, the strongest, however, assuming leadership.

The secondary branches of *Monarda fistulosa*, though apparently forming a straight stem, are formed of axillary branches, which, pushing aside the terminal common peduncles so as to make them lateral, have taken the position of the leading short or central axis. How this method of forming "extra axillary" inflorescence is brought about, I have explained in another paper.[1]

The flowers are centripetal. It takes several weeks from the time the central flowers of the capitulum open before those at the base follow. At this date, October 26th, the flowers begin to open by expanding the lobes of the corolla about sundown. Between 6 p. m. and 9 p. m. twelve had opened. By daylight next morning, in the head I had selected for observation, there were twenty-four. Rest follows, and nothing more is done in this direction till nightfall comes again.

The manner of opening is exceptionally interesting. It is well to examine a flower a day before it would naturally open. The long hair on the upper lip may be almost termed a beard. By lightly pulling this beard the flower bud is opened. The stamens are then seen lying flat on the lower lip, with the lower linear lobe of this

[1] Proceedings of Academy of Natural Sciences of Philadelphia, 1889, p. 58, "On Corydalis flavula."

lip turned inward on itself and pressed down on the anthers as closely as if these latter were in a vise. No pollen seems to have been ejected from the anther cells.

When the fulness of time arrives and the flower opens, the lips springing apart, the lower lip forms a tube and tightly enfolds the filaments. The expansion in different directions of the lips of the corolla is rapid. In less than one minute there will be a space of half an inch between them at their apices. The straightening of the filaments seems to be the chief motor in this movement. The effect is to draw the filaments wholly from the enfoldment of the lower lobe. The central lobe of the lower lip, which until this time has been pressed down on the anthers as already noted, rises at once when the upper lip has drawn them out, and assumes a vertical position. This is the last active effort. Rest then follows in all parts of the flower till next evening, when the little lobe takes another start and falls to a direct plane with the other portions of the lip.

The stamens in the bud are rather longer than the upper lobe of the corolla, while the pistil is rather shorter; hence when these are enfolded by the upper lip, only the upper portion of the stamens with the anthers, project beyond the apex of the lip. The anther sacs seem to burst simultaneously with the expansion of the lips, and while the whole pistil is enfolded by the incurved portion of the lip. It would seem that no pollen would reach the stigmas at this time.

At this juncture the picture is extremely beautiful. In all the force of expansion the anthers on the separate filaments continue connected by their lower filaments and become erect, looking, with a little play of the imagination, as if they had formed a blue basket, the pollen representing white flowers, the basket held up by the two arms over the head of an invisible cherub, as seen in some conventional pictures of a child with flowers. It is not till some time afterward that the divided apex of the pistil protrudes.

At night-fall the next day the stamens begin to wither. The anthers consist of two linear cells, end to end, and so close as to be almost confluent. These two cells do not shrivel simultaneously; the upper one goes first. As neighboring genera have but one cell, this little matter is of interest, as showing the connecting link. During the withering the viscid matter which caused the adherence of the pollen, seems to dry, and the pollen, probably still functionable, is distributed by the winds.

But what is the behavior of the pistil during all this time? It is wholly enfolded by the involute lobe of the lip, though in a few instances one of the style branches may slightly protrude at the apex of the lip; but the full growth and development is the work of another day. After the style has grown sufficiently to carry the branches beyond the apex of the lip, the branches expand, the larger branch curving backward and forming a complete circle. It takes about an hour to complete the circle.

I have utterly failed to form any conception as to how the flower effects fertilization. At the final drying up of the gelatinous pollen, when it is then distributed by the wind or insects, it would be possible for some to be carried to flowers with the exposed styles. But this would involve the later flowers in barrenness, which does not seem to be the case. Moreover the condition of the ova indicates that fertilization is effected in some earlier stage of anthesis; and the, so far as my examination now goes, unerring fertility of every flower, would lead one to suspect self pollination in some obscure way. Every one of 150 flowers in a single head was fertile. In grinding up these flowers with finger and thumb to get at the nutlets 183 perfect seeds were found. This showed that in some of the flowers the whole number of four seeds in each had not been perfected.

The results of my week of observation on this plant were so interesting and so puzzling that I was anxious to have the whole subject reviewed independently of any suggestions of my own. I gave some material to Dr. Ida A. Keller, a close observer in similar lines of study with myself, and the results of whose studies will appear in the following paper.

THE PHENOMENON OF FERTILIZATION IN THE FLOWERS OF MONARDA FISTULOSA.

BY IDA A. KELLER, PH. D.

Although a conspicuous flower and an irregularly shaped corolla are apt to lead one to suspect that these are particular adaptations to aid in securing cross fertilization, yet on the other hand close observations have shown that these characteristics do not always imply the desire to attract insect visitors. Nor is the idea that close fertilization is only resorted to when the arrangements made to favor cross fertilization have failed in their mission, perhaps as generally true as is often supposed. The discovery of fertilization in the bud, recently described by Mr. Meehan in *Malva rotundifolia* tends to confirm this view. Here fertilization, as Mr. Meehan has shown, takes place in the bud, and the case is not exactly as described by Prof. Müller, who says: "As examples of the countless ways in which plants revert to self fertilization in default of sufficient insect visits, I may mention the following:—In some dichogamic flowers the stigmas curl back upon the anthers or other parts which still retain some pollen,"[1] and as an instance of this he gives the flowers of *Malva rotundifolia.* But in the flowers of this plant examined by Mr. Meehan, the deposition of pollen on the stigma lobes and the formation of pollen tubes begin before the stigma lobes are curled backward.

Aside from those cases to which the term cleistogamic is particularly applied: those in which two forms of flowers are produced, one form being small, odorless, inconspicuous and closed, in addition to the ordinary large conspicuous flowers, which are also much less fertile, numerous instances are known where fertilization takes place in the unopened bud. The term cleistogamy might with equal propriety be extended to all cases where fertilization takes place before anthesis, even with the entire absence of any dimorphism, and will perhaps in time be so extended.

An interesting form showing such close fertilization is found in the buds of the ordinary flowers of *Monarda fistulosa.* The figures of Plate XV represent different stages of the opening of the flower. Beginning with Fig. A, the oldest flower represented, we

[1] Prof. Herman Müller. The Fertilization of Flowers. Translated by D'Arcy V. Thompson, p. 591.

notice that the corolla is about to wilt, the stamens have shrivelled up, but the style projects at full length from below the upper lip of the corolla; no pollen was noticeable on the lobes of the stigma, but the lobes are widely separated. The next younger flower, B, shows the corolla still fresh, the style not yet quite exserted, the stamens have wilted, and the stigma lobes are separated. The next younger flower, C^1, has opened and the filaments, which have a fold in the bud, are straightening out; the style is quite hidden under the upper lip of the corolla. Fig C^2 represents the style taken out from the upper lip; the lobes of the stigma are *closed*. Fig. D, the next stage, represents a bud just opened, and the stamens beginning to protrude.

Fig. E^1 represents a closed bud, ready to open. E^2 represents this bud forcibly opened, and E^3 shows the anthers united. Fig. F is about the same as E, but here in F^2 a portion of the corolla is removed in such a manner as to expose the relative position of anthers and style in the closed bud. It was found that the anther cells had discharged their pollen, that the lobes of the style were widely separated, and, in the case represented in the drawing, the longest lobe of the style was actually dipping into the upper cell of one of the anthers. The style, it will be observed, curves over the top of the anthers. Its shape at that time is best seen in Fig. F^3 which represents the style (upper portion) taken out from the bud F. Fig. F^4 represents the same style much more highly magnified, with the pollen attached to it.

I have noticed pollen discharged in small quantity in extremely young buds, but at present it is impossible for me to say just at what period fertilization begins. The stigma lobes are separated at a very early period. One fact which leads me to suspect that fertilization begins at this early period is the presence of peculiar masses which strongly resemble the protoplasmic contents of the pollen grains. These I have represented in C^3, the style of C^1 highly magnified. These masses could not be detected in fresh material, but were invariably found in styles of flowers which had been kept in alcohol. They are inside of the tissue of the style and usually found throughout its entire length, although they are more or less irregularly distributed. To the right of C^3 are three pollen granules, and on comparison with these the yellowish masses in the style seem as a rule smaller, often more or less disorganized, and frequently lumped together. A final decision as to the character

and significance of these masses can be arrived at only after a more careful investigation than I have been able to make so far. This is reserved for some future time.

If it can be taken for granted then that the flowers of *Monarda fistulosa* present the phenomenon of close fertilization in the bud, the question naturally arises, why should the flowers expand, protrude the stamens, and finally the style? This question must as yet remain unanswered. In case of the Fumariaceæ, where, with the exception of *Hypecoum*, according to Hildebrand,[2] close fertilization is unavoidable, the anthers shrivel up as soon as they have deposited their pollen on the stigma, while in the case of *Monarda fistulosa* they become exserted after they have deposited some of their pollen on the style, and remain so exserted for a certain period of time. The same is true of the style. This seems particularly strange in view of the fact that the style usually wilts very shortly after fertilization is accomplished, instead of showing the phenomena of growth and expansion here witnessed. But another observation of Hildebrand's should here be mentioned. In his experiments on *Escholtzia californica* he noticed that in case of fertilization with the pollen from another flower, the petals soon fell off and the style quickly wilted, while in case of fertilization with the pollen from the same flower, the petals dropped at a much later period, and the style remained fresh much longer.[3]

The above observations on *Monarda fistulosa* were made in November; as the time of blooming of this plant extends over a long period, it is possible that it may vary in its method of fertilization at different times of the year. The species, according to Gray, is extremely variable. It is represented in addition to the type by well marked forms of var. *rubra* Gray, var. *media* Gray, var. *mollis* Benth. The chief differences being in the flower, interesting variations in the methods of fertilization may be looked for.

[2]F. Hildebrand. Uber die Bestänbungs vorichtungen bei den Fumariaceen. Pringsheim's Jahrb. für wissen. Bot., VII, Band, p. 455.

[3]Uber die Bestänbungs vorichtungen bei den Fumariaceen Pringsh.'s Jahrb. für wis. Botanik, Bd. VII, 1869–1870, p. 466.

THE PRINCIPLE OF THE CONSERVATION OF ENERGY IN BIOLOGICAL EVOLUTION: A RECLAMATION AND CRITIQUE.

BY JOHN A. RYDER.

The present paper owes its existence to the recent discussion of the principle of conservation of energy in relation to biological evolution,[1] at the Rochester meeting of the American Association for the Advancement of Science, August, 1892, and to the fact that I had made a similar criticism[2] of the views of Weismann and his followers nearly two years earlier, which was published in the same journal. My earlier paper, though not as full and complete a refutation of the erroneous opinions of Weismann as Dr. Miles' article, anticipated the latter's main line of argument by almost or quite two years. While this is true, it affords me great pleasure to find that others are coming forward to criticise, from a scientific standpoint, the very vulnerable and untenable position of the Neo-Darwinians. While it is a great satisfaction to be able to hail the advent of new supporters of Lamarck's doctrine, it may be worth while to call the attention of students to the original position of Lamarck, and the ease with which it may be made to conform to the requirements of the doctrine of the conservation of energy as bearing upon organic evolution. In the Introduction to the "Animaux sans Vertèbres" (Ed. of Deshayes and Milne-Edwards, Bruxelles, 1837, Tom. I, p. 14) occur the following statements of principles.

"First Principle: Every fact or phenomenon of which observation makes us cognizant, is essentially physical, and owes its existence or production to some body, or to the relations between bodies."

"Second Principle: Every movement or change, every active force, and every effect whatsoever observed in a body, depend necessarily upon mechanical causes regulated by their laws."

"Third Principle: Every fact or phenomenon observed in a living body is at once a physical fact or phenomenon, and a product of organization."

[1] Heredity of acquired characters, by Dr. Manly Miles. American Naturalist, XXVI, 1892, pp. 887-900.

[2] A physiological hypothesis of heredity and variation. American Naturalist, January, 1890, pp. 87-92.

Lamarck's laws of metamorphosis or the transmutation of forms, I have rendered as follows from the same source:—

I. "Life, with its peculiar forces, tends to continually augment the volume of all bodies which possess it, and to extend the dimensions of their parts, up to the end of the term of life."

II. "The production of a new organ in an animal body results from a new need which has arisen unexpectedly, and which continues to make itself felt, and which causes new movements to be made to which this need gave origin and maintainance."

III. "The development of the organs and their strength of action are constantly in proportion to the extent or degree to which they are used."

IV. "The fourth law asserts the hereditary transmission of characters acquired under the operation of laws II and III."

The first law tacitly recognizes growth in volume, with its concomitant development of energy, as a factor in evolution, while the second recognizes the fact of physiological or adaptive response. The third supplements the second in a most logical way.

The third law recognizes the quantitative nature of adaptive response in organisms, and has a very wide range of application. It tacitly recognizes what physiologists must now regard as self-evident, namely, that adaptation, so far as that process involves the expenditure of energy, must go on in conformity with the principle of the conservation of energy, a principle which had not been developed as a scientific conception in Lamarck's time.

The "first and second principles," cited above, have some remarkable recent parallels. Lamarck here recognizes the laws of motion, but their connection with the development of energy necessarily escaped him. It is, nevertheless, instructive to cite here Prof. Barker's definition of energy, as given in his recent treatise; "Physics." After some preliminary discussion, Prof. Barker says:— "Energy may be provisionally defined, therefore, as a condition of matter in virtue of which any definite portion of it may be made to effect changes in other definite portions." Now these *changes* referred to by Prof. Barker have to take place through the development of motion, according to mechanical laws. In Lamarck's "third principle," the logical step is taken which leads from the "not living" to the "living" forms of the exhibition of energy. This appreciation, by Lamarck, of the identity of the underlying causes of the physical phenomena of change, and consequently of

motion, and the development of energy in living and dead matter, is most remarkable, and indicates that he must have had some sort of inkling or intimation that the energies of living things and dead things were somehow, and in some sense, to be regarded as kindred or mutually convertible, as implied by the modern doctrine of the conservation of force, through a series of intervening anabolic and katabolic steps, as established by modern physiology. Energy is thus stored or rendered potential in form in living bodies by a series of complex chemical processes, in consequence of which motion, or the liberation of energy as heat, nervous energy, muscular motion, is rendered possible.

Lamarck's conceptions were, however, much restricted in application in his own day. They were evidently most clear to him in animal forms, where motions were obvious to the unaided eye. In the study of the microscopic elements, or cells of animals, little had been done in his time. In fact the science of histology had still to be developed, while modern animal and vegetable physiology were still farther removed from him in the future. We can, therefore, be only the more surprised that the prophetic intuitions of Lamarck should have been as far-reaching as they have since proved to be. If, as has been intimated above, we were to grant him the perception of the great principle of the conservation of energy as viewed at the present time, his principles would require but slight modification to conform perfectly to its requirements, as a working hypothesis in the study of the causation of variations.

We are told by the Weismannians, or Neo-Darwinians, that acquired characters, or such as have been developed through use—exercise of function—cannot be inherited. Since all characters whatever could be acquired only through disturbance of the balance or equilibrium of the functions and metabolism during growth, and consequently the relative proportions and normal functional activities of the parts of organisms, the statement that the effects of *use* and *disuse* cannot be inherited, will hardly need refutation at this stage of my argument.

This leads us at once to the essence of the question, namely: Since all characters had to be acquired, it will naturally be asked, "How, then, from a mechanical or physical point of view, were they acquired?"

Weissmann and his followers formulate an hypothesis of the continuity and variability of an immortal isolated germ-plasm, by means

of which it is believed that new characters will arise in the course of germ-development, the favorable or useful variants of which in the completely developed organisms, will be preserved by natural selection. The further assumption is also made that no character acquired by the soma, or body of the parent, through use, disuse or mutilation of its parts, can be transmitted to its offspring. The antagonism of Weismann and Lamarck are thus seen to be most perfect.

Weismann, however, has latterly been obliged to admit that it was "absurd to say that an immortal substance can be converted into a mortal substance," as pointed out by Prof. Vines. He has also been compelled, as a consequence, to retreat from his position declaring the immortal molecular stability of germ-plasm. He says: "*An immortal, unalterable living substance does not exist, but only immortal forms of activity as organized matter.*" Upon which Prof. Miles comments as follows: — "The material continuity of the germ plasma is therefore discarded and replaced with the conception of a *mode of motion*, manifest in matter that is continually undergoing metabolic changes."

Weismann is therefore logically driven to entirely abandon his original position. Dr. Miles' answer to Weismann's position regarding mutilations is the only sound argument I have met with in this connection. It is: — "The failure of the effects of injuries or mutilations to make their appearance in the offspring, cannot be admitted as evidence to prove the non-inheritance of acquired characters, as the physiological activities of the system [organization of the species] that are required to produce the morphological peculiarities have not been established, and there can be no tendency of the organism to reproduce them."

It is now proposed to show that Weismann's hypothesis is ultimately forced to assume, or take for granted, the modernized Lamarckian theory of the causes of variation, without acknowledging the appropriation. This is especially true, since he admits the existence of "immortal forms of the activity of organized matter," while rejecting the immortal substance.

Since no mass of matter, living or dead, can change its own configuration, except through the motion of some of its own parts, however small, among themselves, it follows that such a change of configuration signifies the expenditure of energy.

If any body or mass of matter, living or dead, be placed anywhere in space in order that its configuration may be changed, the necessary energy and consequent motion competent to do so must be developed: —

(*a.*) By a physical change in some part of the substance of the mass itself, or,

(*b.*) The necessary energy competent to change the configuration of the mass must be developed in material bodies, external to the mass itself, or,

(*c.*) Part of the energy necessary to produce a change in the configuration of the mass must be developed by a physical change in a portion of the substance of the mass itself, in conjunction or simultaneously with an energy, or energies, developed by a mass or body, masses or bodies, external to itself. These three are the only possible conditions.

But, since all masses, living or dead, at the earth's surface are known to be subject to the action of forces developed within themselves, as well as forces developed external to themselves, the third condition (*c*) holds for all masses living or dead.

Therefore the conclusion is that no mass at the earth's surface, either living or dead, can by any thinkable possibility change its own configuration, except under the condition that a combination of internally and externally developed forces, agencies or energies shall cöoperate to that end. In other words, there can be no change of configuration of a body without the expenditure or dissipation of energy.

Now, for the application of these known principles.

Since variations of configuration, no matter whether they affect the adult organism or its early stages, imply variations in the operation of internally and externally developed forces or energies competent to produce such changes of configuration, it follows that all changes in the forms of organisms involve the expenditure of energy. In other words, all variations in the configuration of organisms must be dynamically caused. This is true for the following reasons: No variation in the configuration, either transient or permanent (and therefore, inheritable) of a living body, can be produced without the cöoperation of internally developed motions, consequently, of energies, with externally developed energies or such as are derived from the external world. Whether these cöoperating energies are measurable or not, it is simply impossible for

them not to so cöoperate, since life is characterized by a continuous display of energy. Life is continuous in the material succession and derivation of its individuals, and thus also continuous as to its dynamical or metabolic processes, or the display of its energies. It is safe to say that the continuity of vital energy or the energy of life, is a far more potent agency in the evolution of organic forms, than the continuity and variability of germ plasm, assumed by Weismann. Vital energy and cosmical energy are coexistent and continuously cöoperative. Weismann at last apprehends this.

Therefore, whenever a Weismannian speaks of variations, however he may assume that they are caused, he is forced to tacitly imply that energy is consumed or dissipated in their production, and he is therefore also compelled to tacitly admit the validity of the Lamarckian method of reasoning.

If he tries to escape the snare which has been set for him, as above, he is placed in a still worse and even more compromising position, viz.: the denial of the validity of the universal principle of the conservation of energy.

No character whatever, of any living thing, however trivial, can be acquired without the expenditure of energy and the development of motion in some form; therefore, all characters are so acquired. Consequently, natural selection can choose only from amongst characters such as have been thus dynamically produced, according to Lamarck's original thesis, modified so as to bring it into harmony with the requirements of modern science, or the doctrine of the conservation of energy.

The only way in which a Weismannian, or Neo-Darwinian can now evade the rigorous fatality of the preceding reasoning, is to declare that natural selection includes in the scope of its operations the production of variations. But he is forbidden, and for sound reasons, to do this by the express denial of any such implication or application of natural selection, by the great expounder of that principle, Darwin himself.

Disingenuousness and subterfuge on the part of Weismannians, have hitherto helped to keep the foregoing disagreeable statement of the facts in the background, but the primary fallacy of the Weismannians, or Neo-Darwinians, has now been exposed, and shown to be a sort of biological scare-crow that we may confidently leave to wind, weather and neglect. The mischief that Weismann has done in leading gullible people astray, by most ingeniously throwing

sand into their mental eyes, has not been successfully paralleled in recent times. Weismann's views, as shown above, carry with them the implication of the denial of the validity, within the pale of biology, of the doctrine of the conservation of energy. In that they do this, they must be characterized as unscientific, since they are not in harmony with the spirit of modern science.

So great is the importance of the recognition of the principle of the conservation of energy in the evolution of organic forms, that it is strange that it has not been hitherto declared that it is the very foundation upon which all further progress in the investigation of biological evolution must proceed.

How this principle is to be applied and extended in biological research, in an experimental way in the future, it is obviously not now possible to indicate in detail, but that such was the method according to which Nature proceeded to evolve new forms, seems to be proven by the fact that organic evolution by superposition has occurred, as is shown by countless facts. If characters have been superposed and intensified in their expression, as is beautifully shown by the evolution of such structures as the nervous system and fœtal membranes, it seems that the interacting energies involved in bringing this about have operated cumulatively. That is, that every gain of surface for better respiration and nutrition, and combinations of both, set the processes of the development of physiological energy going at a greater rate of efficiency, which would accelerate the process of evolution and its morphological possibilities. The rates at which these energies, internally and externally developed, shall interact, cannot be determined by natural selection, but by growth and the motion of parts and particles dependent upon it.

Weismann nowhere in his prolix and tedious essays, except in one of the very latest answers to his critics, steps aside to consider energy in relation to the problems he is discussing. He is simply oblivious of the existence of such a thing as energy as affecting the question before him. His facts may or may not have the value he assigns them, his reason often being of the shallowest and most commonplace texture, as for example, when he says: "The object of this process (sexual reproduction) is to create those individual differences which form the material out of which natural selection produces new species." In this case he has mistaken an effect for a cause, and has assigned as the object of sexuality an end or final cause upon which neither he nor any other man can legitimately

dogmatize. This absurd view amounts to the same thing as asserting that organisms have the power to develop physiological processes with conscious foresight, so as to avoid harm coming to their race! This is on a par with Balfour's reasoning with respect to the cause or reason of the existence of the polar bodies, namely, as a preventive of parthenogenesis!

The criticisms of E. B. Poulton, in a foot-note on p. 425 of Weismann's Essays, (Eng. Trans.) are similar to those offered long ago by Dr. C. S. Tomes. Poulton, like his predecessor, criticises my views on the mechanical genesis of tooth-forms, without knowing what he is talking about, evidently not having read my paper. He says: "It may be reasonably objected that the most elementary facts concerning the development of teeth, prove that their shapes cannot be altered during the life-time of the individual, except by being worn away." "The shape is predetermined before the tooth has cut the gum." "Hence the Neo-Lamarckian school assumes not the transmission of acquired characters, but the transmission of characters which the parent is unable to acquire!" Anything more unfair or indiscriminating than the above could not be written. I am charged with making statements I never made, and never had the slightest intention of making. As I am the originator of the doctrine of the mechanical genesis of tooth-forms, I will here say in reply that Poulton and Tomes cannot *disprove* that the forms of the crowns of teeth of mammals are *not* altered in shape *in other ways* than by wear, or by means of stresses and consequent permanent strains. If, as I have shown in my original essay, (Proc. Acad. Nat. Sciences, 1878,) crystalline bodies can be permanently bent and strained by persistent stresses, what proof is there to the effect that even hard enamel caps cannot be so altered in the life-time of the adult? Moreover, I have shown that all the changes of the crown-forms of the molars of the long series of Artiodactyls, have conformed with mechanical exactitude to the requirements of the various degrees of lateral motion of the jaws, and that where these lateral motions were absent, lateral crown-modifications were also absent. In other words, the degree of lateral modification is correlated with the degree of lateral motion, or sweep of the jaws. Later evidence has tended to show that the development of new cusps and roots, in certain cases, takes place at points of maximum wear in certain teeth in the domestic cat, as pointed out to me by my colleague, Prof. Jayne.

This show of logical acumen by my Anglican critic, is useless; the facts are so overwhelmingly against him, as respects the evidence for a mechanical theory of the evolution of the teeth, that there is no other way in which they can be cöordinated. This evidence is cumulative in amount and character, and is also an illustration of the cumulative effect of the secular display of a portion of the energy dissipated by a series of organisms, straining even their hard parts into new configurations which have became hereditary, because the soft parts underlying them have been correspondingly modified and moulded by physiologically developed stresses, which have become, so to speak, permanently expressed as physiological strains.[3] As yet there is no proof of the slightest scientific value, that dynamically acquired and thus cumulatively developed characters cannot be inherited, despite all the evidence, mostly worthless, accumulated by Weismann, Poulton and others. For the unfair manner in which the term "acquired character" is used in all sorts of senses, restrictions and limitations by Weismann himself, see a criticism[4] by C. C. Nutting.

In point of fact, every time a new character appears it is self-evident that energy must be expended in order that the necessary movement of parts may be effected; in order that a new form of the organism, or of some part of it, may be assumed. *So far from its being a fact that dynamically acquired characters cannot be inherited, it is an irrefragable fact that dynamically developed characters are the only ones that can be inherited.* How this is accomplished is a matter for further research.

If refuge is sought in a germ-plasm in which capacities for variation are assumed to inhere, it must be assumed that it operates according to a law peculiar to itself, and in defiance of all known external and physical influences, such as modify or control the movements of the constituent particles and masses of all other bodies. Heredity seems to inhere *a la* Weismann in the germ plasm, something after the manner of the inherence of "horology," or time-keeping properties in a clock, as long ago suggested by Prof. Huxley, when he was exposing the untenable position of the advocates of "vitality," as a kind of energy with no affiliations to other kinds.

[3] The words "stress" and "strain" are here used by me in the same sense as by engineers and physicists.

[4] American Naturalist, XXVI, 1892, p. 1009.

Prof. Morse's position that the culture experiments of Dr. Dallinger in training monads to withstand gradually increased temperature, until endurance of 158°F. was reached, was an illustration of *natural selection pure and simple,* is also an illustration of the oversight by Neo-Darwinians of the essential energy-factor of the problem.

Since the monad cultures were kept continuously at a gradually rising temperature, there must have been continuous and successive responses in the mechanisms of the protoplasm of the successive generations to the new conditions, else adaptations could not be effected. The failure to apprehend the fact of the continuity of adaptive processes, while the whole burden is thrown upon the discontinuous selective process, is most extraordinary. If none of the monads involved in the earlier stages of the experiment, had undergone certain internal changes owing to the persistence of the new energy-conditions of heat, none would have been modified so as to be selected as the progenitors of a series of generations, capable of sustaining even greater extremes of temperature.

The adaptive process in living forms where energy always is continuously involved, may be fittingly compared to the idea of continuous number, as understood in the calculus, in contrast to discontinuous or integral number in ordinary arithmetic, and typical of the discontinuous process of the selection of integers, or individuals of a race by means of natural selection. This energy-factor cannot be so conveniently ignored, as it is every time the Neo-Darwinians assert that the development of new characters is entirely due to natural selection.

In the paper by the writer, published in 1890, the idea was advanced that heredity itself must be ultimately interpreted in consonance with the doctrine of the conservation of energy. It was then stated that a theory of heredity something like the following would have to be assumed:—

"In the first place, the supposition of a germ-plasma distinct from the plasma of the parent-body is a needless interjection into the machinery of hypothesis of biological evolution. It does not make the matter one whit clearer to suppose that the germ-plasma is necessary, than to suppose that *all of the living plasma of any and every distinct species is an idioplasm, or is specific in so far as that species is concerned.* If we now suppose, as a consequence of the action of the principle of physiological division of labor, first pro-

pounded by H. Milne-Edwards, that *all the plasma, or the whole of the specific protoplasm or idioplasm of the organism, becomes physiologically differentiated and incapable of undergoing embryonic development, except that of the germ-cells or germinal plasma,* as long ago urged by Professor Huxley, we get the same result as that reached by Weismann without involving ourselves in the consequences which beset his hypothesis. *This germinal matter is the only functionless and idle plasma in the parent body,* capable of growing and consequently of multiplying its substance within the parental organism at the expense of the surplus metabolism of the latter as a whole. Moreover, the germinal cells are alone capable of detaching themselves, or being detached, from the parental organism as products of over-nutrition, which have become useless to the life of the parent, as assumed in my preliminary paper "On the origin and meaning of sex." This recognizes the apparent fact of the setting aside or isolation of the germ-plasma, but does not make that fact the cause of the stability of species through the continuity of processes of growth, and the assumed but not empirically demonstrated isolation of such germ-plasma. My interpretation is in absolute accord with the requirements of the principles of modern physiology, while the hypothesis of Weismann and his followers is in conflict with those principles, and ultimately, as a necessary consequence, with the still more comprehensive principle of the conservation of energy. Modern physiology, as well as the doctrine of the conservation of energy, positively forbids us to interpose any barrier between the plasma of the parent-body and that of the germ cells, as is done by the promulgators of the hypothesis of the continuity and isolation of the germ-plasma. To do so robs us of the possibility of appealing to the agency of the workings of metabolism as the efficient cause of the modification of the germinal matter. Since metabolism, and all that it implies, is the only agent to which, according to modern physiology, we can appeal, without interjecting gemmules, plastidules, pangens or some other accessory and needless agency into living organisms, as the efficient agents in the transmission of hereditary traits, we are restricted in our choice to metabolism alone. In this way only is it possible to get rid of a *deus ex machina* in the form of an idioplasm in the sense first implied by Nägeli, or of the gemmules of Darwin and Brooks, the plastidules of Haeckel, the pangens of De Vries, or the physiological units of H. Spencer.

"The preceding paragraph contains, in essence, my own hypothesis according to which all the facts of hereditary transmission and variation may be coördinated without losing or rendering unavailable the advantages which may be derived from the supposition that acquired characters may be transmitted.

"In my view metabolism itself becomes the means of transmitting the changes in the adult organism, due to the complex interaction between it and its surroundings to the idle, functionless and passive germ-cells, because it is a demonstrable fact that these are the only cells in a multicellular organism which have no work to perform which is of direct benefit to the individual life of that organism, unless it may be to take up the surplus nutriment not used by the metabolism of the parent-body in the secular exhibition of the sum total of its physiological energies, in the struggle for existence."

According to my view the idioplasmic, or specific molecular character of the plasma of the germ-cells, in common with that of the protoplasm of the whole body (which latter always tends to repair injuries, or even, in lower forms, replace lost parts,) tends, in virtue of its dynamically acquired specific traits, to repeat the organization of its parent type, in the course of its development, not because it is something different from the protoplasm of the cells of the rest of the body, but because it is wholly unspecialized and without other physiological differentiation.

The automatic processes of heredity are an accumulated result of the continuous interaction of internally and externally developed energies during phylogeny. The exact manner in which these have been registered and preserved in germinal cells, or in parts of organisms which have the power to reproduce the whole organism, we cannot yet hope to explain, in that protoplasm itself is a body of such complexity and capability of transformation, that nothing else approaches it, as is proved by the chemistry of its bye-products, the carbon compounds.

We can only suggest that "molecular impressions experienced in the course of variations in the modes of manifestation of, or disturbances of the balance of the metabolism of the parent-body are supposed upon this view to be transmitted as molecular tendencies to the idle or passive plasma of the germ-cells. Variations in the molecular constitution and tendencies of the germinal matter are supposed to thus arise at different times in the same parent, and that, conse-

quently, successive germs may be thus differently impressed. In this way also the molecular tendencies of the plasma of the germ-cells of different individuals may be also modified simultaneously or successively through the effect of enforced changes in the metabolism of multitudes of contemporaneous adult individuals of the same species, thus leading to a tendency toward concurrent or simultaneous variation of offspring in the same or a similar direction.

"It will be seen that this is the only hypothesis which renders the possibility of concurrent or simultaneous variation within the limits of a species either conceivable or intelligible. It also lends itself to an intelligible comprehension of the phenomena of the correlation of the growth of parts, and it is also the only view which holds out any promise of cöordination with the highly ingenious and suggestive hypothesis of Prof. Wilhelm Roux.[5]"

If we now remember that, as development advances, the influence of external disturbing agencies diminishes, so that it is far easier to produce monstrosities or modifications at an early period of development than at a later one, we see that the early steps of ontogenetic processes are far more easily modifiable than the later ones, owing to variations or disturbances of the externally and internally cöoperative energies manifested during growth. We thus add an important qualifying statement to what has preceded, and one that confirms the preceding in a remarkable way, since it serves to prove that the less specialized states of ontogeny are more sensitive to disturbing influences, than the later and more specialized ones.

"It will be at once perceived that my hypothesis of the acquisition of variations and their transmission is the simplest that has yet been offered. It interjects nothing hypothetical into our conception of the physical substratum of living organisms, except the necessarily unknown and unknowable constitution of the molecular factors of metabolism, and thus brought into harmony with the all-inclusive doctrine of the conservation of energy."

Prof. Miles closes his article as follows:— "Questions like these must be answered, to furnish satisfactory explanation of biological activities, and theories of nutrition and heredity in which energy is not recognized as one of the prime factors in every vital process should be received with caution, and the fallacious arguments based upon them estimated at their real value."

---

[5]Der Kampf der Theile im Organismus. 8vo., pp. VII, 244, Leipzig, 1891.

Following these observations, my own remarks at the close of my paper of 1890 may be appropriately quoted :—

" In that the doctrine of the isolation of the germ-plasma is in irreconcilable conflict with the great cardinal principle upon which the whole fabric of modern physiological science rears its stately proportions, namely with the general theory of metabolism, and, consequently, with the still more imposing and universal principle of the conservation of energy, we therefore realize what a colossal fabric of speculative rubbish must be consigned to the limbo of untenable and forgotten hypotheses, in what is represented by the misguided labors of the advocates of the existence of an unalterable germ-plasma."

EXTRA-MORAINIC DRIFT IN THE SUSQUEHANNA, LEHIGH AND DELAWARE VALLEYS.

BY G. FREDERICK WRIGHT.

In the autumn of 1880, the late Professor Henry Carvill Lewis and myself began the exploration of what we supposed was the boundary of direct glacial action in Eastern Pennsylvania. The work of field exploration was substantially completed in 1881. Our report constitutes volume Z in the series published by the 2d Geological Survey of Pennsylvania, and appeared in 1884.

After accepting with little question the delineation of the terminal moraine from the New Jersey report for that State, we began work in Northampton County, Pa., and soon succeeded in tracing a well marked moraine across the county from near Belvidere, in New Jersey, to the vicinity of Offset Mountain, in the Kittatinny Range, a few miles northeast of the Wind Gap. At that time our attention was not sufficiently directed to the more dispersed erratics and thinner glacial deposits which usually extend in advance of the moraine, and which, subsequently, we came to recognize as the "fringe." The facts concerning the "fringe" came prominently to light in connection with my own further investigations in the western part of Pennsylvania, and in my own investigation in the States farther west. In my reports on that region I soon ceased to give special attention to moraines, and confined attention to the border of the fringe, and in my map in the volume "The Ice Age in North America," the legend indicating the terminal moraine across Pennsylvania, gives place in the States further west to one marking the southern limit of the ice sheet.

In view of these facts it is significant that in his report (p. 201), Professor Lewis uses this language: "It is possible that traces of this fringe might be detected in Eastern Pennsylvania and in New Jersey. In fact, occasional transported boulders do occur upon several hilltops, just in front of the moraine, in the vicinity of the Susquehanna and Delaware rivers, and in New Jersey, which I find it difficult to explain on any theory of a flood, and which may be of like origin with the fringe as developed farther west. Facts observed by other geologists in more western States, and published since this report was written, confirm my impression that this fringe is destined to play an important part in glacial geology."

To this I have added, in my volume on the Ice Age referred to, the statement that in driving over the country, between New Brunswick and Metuchen, N. J., in company with Professor Cook, I had observed what I considered unmistakable evidence of this fringe a few miles south of the well defined moraine. (Ice Age, p. 136.)

So much it is proper to say to indicate the reasons urging me to re-examine the field where Professor Lewis and I began work on the glacial boundary. This is the more important since Professor Lewis's death has left unpublished a large amount of material in the hands of his executors, which is at present inaccessible. This consists of notes collected upon the terraces of the Atlantic rivers, which he expected soon to publish, and to which he makes occasional reference in Vol. Z, as discussing more fully many topics barely alluded to in that report. Of his views I had much knowledge, from our constant association in the field. For some time past reports of phenomena, seemingly inconsistent with the interpretation which we had put upon the facts, have been gaining currency, but I have not dared to venture any criticism until a personal re-examination of the field had been made. This I have had the opportunity of doing during the past season, and I herewith submit the results for consideration and criticism.

The principal statements which had perplexed me were:—

1st, That of Mr. McGee (Am. Jour. Sci., vol. 135, pp. 377, 378, 381), that from Harrisburg to the terminal moraine at Berwick there are evidences of a submergence during glacial times, which allowed still water deposits to accumulate 500 feet above the present river level.

2d, That of Professor Salisbury, that glaciated stones had been found by him near Sunbury, 600 feet above the river. (Adduced by President Chamberlin, Bul. Geol. Soc., vol. I, p. 473. Reiterated by Salisbury, vol. 3, p. 180.)

3d, Statements of Mr. McGee that there is evidence of a land submergence in the Delaware Valley of at least 400 feet in the vicinity of the terminal moraine. The evidence of this is principally drawn from a section of the valley five miles below Belvidere. (Am. Jour. Sci., vol. 135, p. 379.)

4th, Statements by Professor Salisbury, seeming to imply that evidences of ice occupation are found in New Jersey at High Bridge, Pattenburg and Monmouth Junction, and in Pennsylvania at Falls-

ington, a few miles west of Trenton, and Bridgeport, in the valley of the Schuylkill, a few miles west of Philadelphia.

The principal conclusions arrived at by Professor Salisbury are involved in the following extracts. After having minutely described the deposits at Pattenburg, High Bridge, Oxford Church and Little York, N. J., and the excessive oxidation and disintegration which his supposed extra-morainic drift has suffered at these places; and having expressed the opinion that the phenomena most certainly indicate a glacial period several times older than that with which the terminal moraine is connected, he goes on to say:

"The phenomena here described as indicating a drift-sheet older than that represented by the moraine and the drift north of it, are not confined to Hunterdon and Morris counties. The extent of the territory over which these phenomena occur is not known, though many facts concerning its extension are already in the possession of the Survey. The railway cuts southeast of New Brunswick afford similar evidence in this part of the State. Glacial-striated boulders have also been found between Monmouth Junction and Deans, along the line of the Pennsylvania railway, and at Kingston on the Millstone River, three miles northeast of Princeton, though they are by no means common in either place.

"In Pennsylvania there are drift deposits well south of the moraine in similar situations. Glaciated boulders, imbedded in clay which presents the general aspect of till, have been found near South Bethlehem, several hundred feet above the Lehigh River, and at various other points south of the Lehigh, at distances from the moraine comparable to those at which the corresponding formation in New Jersey occurs. Drift closely resembling till, and containing striated rock material, occurs on the west side of the Delaware, near Fallsington, three or four miles southwest of Trenton, and, with Mr. C. E. Peet, the writer found similar deposits at Bridgeport, Pa., opposite Norristown, still further south. Bridgeport is the southernmost point at which glacially-striated material has been seen by the writer. Glaciated boulderets were here taken from clay of such character that, were the locality known to have been covered by ice, its reference to till would be fully warranted. Bridgeport is about fifty miles south of the terminal moraine.

"It is not intended to convey the impression that every region where glaciated stone may be found was necessarily once covered by glacier ice. The possibility of transportation of glaciated material beyond the edge of the ice by water, is distinctly recognized. But it is not believed that water alone, or water-bearing glacially-derived bergs, could produce all the results which are here recorded. Neither the structure of the extra-morainic drift, nor its physical make-up, nor its geographic or topographic distribution, is consistent with such an hypothesis.

"At several points in New Jersey, south of all the localities thus far mentioned within the State, there are topographic features which are easy of explanation if ice once extended to the region where they occur, but which seem to be very difficult of explanation on any other hypothesis. The features here referred to characterize the region from Washington, Middlesex county, southwest to Fresh Ponds and beyond, and also the region east of Trenton, from White Horse to Hamilton Square. The topography in these regions is very much like that of a subdued terminal moraine.

"The determination of the southern limit of ice action during the earlier glaciation is likely to be a matter of some difficulty. In its southern extension the ice reached the region of the 'yellow-gravel' formation." (An. Rep. of State Geologist for the year 1891, pp. 106, 107.)

It is fair to say that Professor Salisbury informs me that he does not now think the ice of "the first glacial period extended farther south than High Bridge and Pattenburg," and would direct special attention to the paragraph quoted, in which he speaks of the possibility of transportation of glacial material by water. But as we have to deal with the report as it stands, it is necessary to call attention to its natural interpretation as it falls into the hands of the ordinary reader, in order to correct the errors into which he would be unwittingly led. Such a reader must be informed that when Professor Salisbury speaks of extra-morainic drift extending to the "yellow-gravel" (in quotation marks), he does not mean the yellow gravel as it is marked upon the latest map of the New Jersey Survey, but some yellow gravel which he has discovered a considerable distance farther north. In his paper before the Geological Society, however, he uses language which cannot so easily be explained, saying that boulder clay similar to that at High Bridge and Pattenburg, and whose existence must be explained in the same way, is found south of Pattenburg to a distance fully twenty miles south of the moraine. In the same paper he also speaks of a locality "fifteen miles southwest of New Brunswick," where phenomena are exhibited which present evidences of direct glacial action.

In the light of my investigations this summer, I think I am able to detect the cause of the conflicting statements of facts by these eminent observers, and to eliminate some very serious errors of interpretation which one or other of them has brought into the discussion.

As I had surmised, and repeatedly urged in publications upon the subject, the cause of the error is to be traced to the undue

emphasis which was at first placed upon the terminal moraine as marking the southern limit of the area occupied by ice during glacial times. Into this error Professor Lewis and I fell at first equally with others, though I believe my experience led me to free myself from it sooner than most others. The fact is that in Eastern Pennsylvania, and in portions, certainly, of New Jersey, the "fringe" does extend a considerable distance beyond the terminal moraine. In the Susquehanna, the southern limit of the ice was several miles below Berwick. While the Delaware Valley was occupied by a lobe of the glacier, which extended in the axis of the valley to the Musconetcong range, five or six miles southeast of Easton, and about fifteen miles south of Belvidere, which has heretofore stood as the limit. The supposed evidences of a farther extension of the ice southward are readily explained, in a manner which I will presently detail. The evidence upon which these conclusions are based is as follows:

1st, as to the Susquehanna terraces: I began my investigations at Harrisburg. Here I had the advantage of the minute local knowledge of Dr. Harvey B. Bashore, of West Fairview, who had been in correspondence with me concerning the terraces of the vicinity for more than two years. The terraces are for the most part situated in the city of Harrisburg, and Dr. Bashore has scoured the country far and near, and speaks with no ordinary authority upon the subject. I visited the principal points with him, and am prepared to endorse his concise statement of the case which he has written out for me at my request.

"The first terrace at Harrisburg is 28 feet above low water (290 A. T.) upon which Front street is mainly built, and is composed of clay suitable for brick-making, and contains many boulders of large size (4 to 5 feet in diameter), composed of conglomerate and sandstone from the mountain, through which the river has cut a gap a few miles above. This deposit is distinctly marked on both sides of the river.

"The second terrace is 46 feet above the river, but it is not plainly marked. Third street, however, is in a great measure built upon it. This bed is composed of gravel, which has in it some granite and gneiss, and contains large and small boulders all rounded, and is capped by two to three feet of fine loam.

"The third terrace is 90 feet above the river, and forms the plane of Sixth street and part of Fifth. This deposit, which gives a good perpendicular exposure of 15 feet, is composed of fine gravel, some portions of which are granite and gneiss. A few boulders appear in it, from two to three feet in diameter. All are well rounded, and

the whole is capped by from four to five feet of fine clay. Almost all of the boulders occur in the gravel.

"From this terrace the slope is gradual down to Paxton Creek, on the opposite side of which a slate hill (Allison Hill) rises very abruptly, and is covered on the top by the fourth terrace.

"The fourth terrace is 130 feet above the river, 420 A. T. At Walnut and Herr streets there is a very good exposure showing the gravel resting upon the slate.

"The thickness of the deposit is about 20 feet, and it is capped by fine brick clay. The gravel bed, especially at its upper part, presents a peculiar white appearance compared with the overlying clay—the line of junction between the gravel and the clay being very distinctly marked. Some rounded boulders occur in it two to four feet in diameter, mostly in the gravel. I found one, however, in the clay. The gravel contains a few pebbles of granite and gneiss, but none were found more than two or three inches in diameter. Above this point (420 A. T.) I could find no positive evidence of water action, although I carefully examined all the surrounding hills and mountains north of Harrisburg."

The occurrence of granitic pebbles in these terraces is of great significance, since it fixes them as contemporaneous with, or subsequent to, the glacial period, for there is no outcrop of this material anywhere in the watershed of the Susquehanna above Harrisburg. The only way the granite could have come wthin reach of Susquehanna floods was by ice transportation into its headwaters, from Canada or the Adirondacks. This upper terrace, therefore, corresponds with Mr. McGee's Columbia formation.

In following up the river I went above the first three ranges of mountains to Dauphin, and drove over Fourth Mountain to Halifax. Near the mouths of the small valleys occupied by Clark and Armstrong creeks, there are terrace accumulations up to about 150 feet above the river, composed for the most part of rounded material, which might have been brought down the creeks. But at higher levels there were no terraces. This was a drive up the river of about fifteen miles, and took us gradually over two slopes, reaching about 900 feet above the river.

We next went up the river to Selinsgrove, about six miles below Sunbury, and examined the country for a few miles east of the river. Here we found the rounded pebbles of the terrace deposit ceasing abruptly at a height of about 200 feet above the river, or about 650 feet above tide. This corroborates Professor I. C. White's observations, as recorded in G 7 p. 363 of the 2d Pa. Report.

Then ascending the river to Sunbury, we drove some miles east toward Klinegrove, by a route which took us over a typical variety of high and low land, then westward some miles back of Shickilimy, then up both branches of the Susquehanna to Montour's Ridge, and over the higher land intervening. The result was to convince us that about 200 feet limits the deposits of pebbles which can be in any way connected with terraces of the present river, and that there were absolutely no deposits that could reasonably indicate the presence of land ice over that region at any time. A boulder of gneiss one foot in diameter is reported from the fourth terrace at Northumberland, 175 feet above the river. (G 7, p. 336.)

We then ascended the river to Bloomsburg, and drove westward to join the line of Lewis's terminal moraine near Knob Mountain, a mile or two north of Orangeville, in Columbia County. Here we found extensive terrace deposits in the valley of Fishing Creek, rising something more than 100 feet above it. We also found considerable deposits of transported boulders on the hills north of Lightstreet, extending in a practically continuous sheet from the terminal moraine which Lewis had located on the farm of Wm. Beck, two miles north of Orangeville. Without much question the ice extended here on the hills west of the river almost as far southwest as Bloomsburg, and covered to a height of from 300 to 400 feet above the river, the projection of Montour's Ridge which extends northeastward from the city. (See G 7, p. 256.)

A drive over the uplands on the east side of the river as far as Mifflinville, showed that there was nothing which could be attributed to glacial action over that area until reaching a point about two miles south of Mifflinville, where a few conglomerate boulders and some scratched stones appeared about 500 feet above the river. It is perhaps possible that these may have been derived from the higher outcrops on Nescopec Mountain, two or three miles to the east. But they now rest on the surface of Hamilton slate, and are separated from the mountain by a valley of considerable depth, eroded by a small creek. So scarce, however, are these remnants of the ice age that they escaped the eagle eye of Professor I. C. White. (G. 7, p. 278.) But in view of the abundant signs observed by him, as well as by myself on the other side of the river, I have little hesitation in bringing the border of the glacial field on the south side of the river, down to the west boundary of Mifflin township. Professor White is also probably right in opposition to

Professor Lewis in bringing the ice border down to Green Creek on the north side of Knob Mountain, in Orange township. (G. 7, p. 217.) Thus it appears that the section between Bloomsburg and Berwick (Am. Jour. vol. 135, pp. 376, 464), upon which Mr. McGee depends for proof of his Columbia submergence of 500 feet in this region, is within the attenuated border or fringe, as I had surmised, and hence fails to prove what he supposed.

On passing over into the valley of the Lehigh, we first drove from the Glen Summit Hotel to Hazleton, during which we satisfied ourselves that there are no glacial deposits much farther south than the terminal moraine, as there marked by Professor Lewis at Drums, where a short distance to the south, the outcropping coal measures form a bold obstructing wall several hundred feet above the valley of Nescopec Creek. But the region beyond is so broken up by mining operations, and with the disintegrating debris of the Pottsville Conglomerate, that I should not put entire confidence in such investigations as I was able to make.

In the broad anticlinal valley crossed by the Lehigh, between Mauch Chunk Mountain and Blue Ridge, however, the opportunity for crucial tests is as good as could be desired. Here we found that the evidence of direct occupation by glacial ice extended at most only a few miles beyond the moraine, as marked on Lewis's map. Extensive drives up the valley of Big Creek, near the mountain north from Weissport, across the valley both of Big Creek and Aquanchicola Creek to the Lehigh Water Gap, as well as south from Lehighton, up and across the valley of Mahanoy Creek, demonstrated to my satisfaction that glacial ice had never extended to within ten miles of the Lehigh at this point. At Lehighton, however, there is a well defined pebbly terrace rising about 75 feet above the river. The material is well rounded, and mixed with yellow sand and clay. These terrace deposits do not appear above that level anywhere between Lehighton and the Water Gap, either on the Lehigh or on its tributaries. But on the gentle slopes of Mauch Chunk and Big Creek Mountains there are many pebbles which have evidently been brought down in the slow process of erosion. These are collected at various heights in special quantity in front of the openings into the mountains effected by the side streams, and in many cases clearly represent ancient deltas when the whole drainage was at a higher level.

East of the Blue Ridge I was joined by Professor A. A. Wright, who had been spending the summer at Flemington, N. J., and who at my request had been giving attention to the deposits near by, at High Bridge and Pattenburg. Hence I will begin with the conclusions concerning those deposits so fully described by Professor Salisbury and classed by him as glacial. And certainly at first glance they do look enough like glacial deposits to "deceive if it were possible the very elect." That in this case it is possible, I think is proved by the fact that they have probably deceived Professor Salisbury. As described so well by him (N. J. Geol. Sur. 1891, p. 103), these deposits show only slight signs of stratification, and contain, mingled through the clay to a depth of from ten to thirty feet, many boulders large or small, some of them several feet in diameter, and most of them partially rounded. There are also many smaller fragments of slate, nearly all of which are scratched. One well scratched fragment, about two feet long and one and a half wide, was observed well scratched on one side. At Pattenburg also we found two or three of the boulders of harder rock somewhat scratched. But such are very rare, and the rounding was not quite characteristic of a glaciated region.

A noticeable, and I believe, a crucial fact in determining the character of the deposit, is that the material is local. The boulders are all of a gneissoid character, such as compose the mountain which in both places rises several hundred feet above the deposits directly to the north, and down which boulders of the same sort are creeping in majestic array in every direction. I did, however, at High Bridge, note one small pebble which was possibly Potsdam sandstone. Furthermore these mountain flanks were doubtless once covered with strata of limestone and slate, such as are still found in close proximity in the synclinal basins which have escaped erosion. Hence it is possible, if not probable, that the fragments of slate are the remains which have escaped absolute destruction by the erosive agencies which have been so long at work in this whole region. The scratches might well have been made in the process of creeping down the disintegrating mountain side, which secures almost exactly the same mechanical forces as the movement of a glacier does.

Creep scratches engaged the attention of Professor Lewis and myself at the outset of our investigations in Pennsylvania in 1881, and are discussed at considerable length both on p. 96 of vol. Z, in the account of phenomena at Hickory Run, in Carbon County, and in

other places. They were also noticed on the slate rocks at Bangor. I have taken pains this summer to revisit some of these places, and am more than ever impressed with the fact that a small scratched surface, and a limited number of scratched pebbles do not prove a glacial period. Near Ackermansville, in Northampton County, Pa., I observed excellent striæ on the slate rock in a railroad cut, made by the loose material which has slid down the bank since the cut was opened a year or two ago. I also succeeded in securing well marked scratches on slate pebbles by an artificial slide which I myself produced in the bank at Pattenburg.

It is fair to say, however, that we found evidence of the true fringe of the ice age so near to both High Bridge and Pattenburg, that it is not much of a strain on the scientific imagination to suppose that the ice here just crossed over Musconetcong Mountain and ended for a while at these points. But that this was not the case, I think is evident from the considerations following:—

1st. The cause already adduced is entirely competent to produce the results. There is no occasion to introduce a greater cause.

2d. The absence, as just stated, of all material foreign to the immediate locality, demonstrates the local character of the cause.

3d. The appearance of foreign material as an overwash gravel in the valley of the Musconetcong River, eight or ten miles to the northwest just beyond Junction, shows that foreign material would have been brought by glacial ice, had it extended so far. Here pebbles of the enduring and well defined Medina sandstone, and Oneida conglomerate, appear to a considerable extent, derived probably from the moraine to the northeast, in which it has its headwaters. But on the low summits of the parallel Pohatcong Mountain, south of Washington, we failed to find any foreign material in two cross sections which we made under favorable circumstances. In the valley of the Pohatcong, at and below Washington, however, the foreign material is so abundant and of such size as to make it probable that the glacial ice overrode Scott's Mountain. Boulders of the Medina and Oneida sandstones occur here south of Pohatcong River, in connection with a deposit of large extent of finer material capped with loam and clay. The railroad also makes two other good sections in till south of the mountains. From this point on to the north these characteristic foreign boulders are found at frequent intervals on the road leading up the south side of Scott's Mountain toward Oxford Furnace, to a height of 360 feet

above the river. These boulders increase in abundance on the north side, but are mingled in irregular fashion with the disintegrated material of the gneiss of which the mountain is constituted. It is this disintegrated local material, both here and at High Bridge and Pattenburg, I presume, which Professor Salisbury has attributed to an earlier glacial epoch. Two or three miles farther north begin the accumulations which have been called the terminal moraine. It is important to notice that there is continuity in the distribution of this foreign material from the moraine southward over Scott's Mountain into the valley of the Pohatcong at Washington, but that the continuity seems to be broken at the low ridge of Pohatcong Mountain.

On going farther west this same continuity in the distribution of foreign material in front of the moraine occurs down to an equal and even longer distance south. The Medina and Oneida boulders are very abundant at Little York, which is near the summit of

Scott's Mountain, (400 feet above the river Pohatcong, and 600 above the Delaware), and continues to Brass Castle, on the Pohatcong. On going still farther west, we found the same continuity of foreign boulders extending through Harmony over Marble Mountain, a projection of Scott's Mountain, while the plain bordering the Pohatcong Creek was deeply covered with Medina and Oneida boulders down to the vicinity of Phillipsburg. These must have been derived from the deposits which had been brought over from Scott's and Marble Mountains by glacier ice. Going still farther south on this line within five miles of the Delaware, we found Medina and Oneida boulders all along to the summit of a col on Musconetcong Mountain, two or three miles west of Bloomsbury, and at a height of something over 500 feet above the river. Here a boulder of Medina was found measuring 3x2½x1 feet. Another still retained a very perfectly scratched surface.

The other portions of the mountain here rose about 200 feet higher than this col, and upon them we failed to find foreign boulders. But on following down a small stream leading south to another Little York on Hikihokake Creek, bordering the Triassic shales, which here begin, we found many pebbles of Medina sandstone distributed about its ancient delta. But they did not extend far out on the Triassic deposits. A long detour upon these showed that they were perfectly free from foreign material. Though flanking the gneissoid rocks of Musconetcong Mountain, which rises several hundred feet above them, there has been no southern transportation of material over that area since the original deposition of the Triassic period. This seems to prove conclusively that glacial ice once extended within five miles of the Delaware River, as far south as the summit of Musconetcong Mountain and no farther.

Some facts in confirmation of this inference occur at Pattenburg, which is just over the watershed to the east, leading into the Raritan River, and not more than seven miles distant. The supposed glacial deposit there lies near the headwaters of Mulhockaway Creek, which in the upper part separates the gneissoid rocks of Musconetcong Mountain from the Triassic rocks to the south. The Triassic rocks rise upward of 400 feet above the stream on the south, while the gneissoid rocks rise about the same height on the north. The Triassic deposits are here of a conglomerate character, often containing pebbles a foot in diameter, some of which seem to have been

derived from the Medina group. Some of these occurred near the Pattenburg cut, and at first deceived us. But subsequently we found portions of this Triassic conglomerate in places in the cut, and satisfied ourselves that there was nothing but local material there. The gneissoid rocks have worked into the valley faster than the Triassic, but at the same time the stream has cut down deeper on the side occupied by the gneiss rock. There has been no intermingling of material as there must have been had glacial ice covered the whole area. Musconetcong Mountain was the limit of glacial action east of the Delaware River and west of Bloomsburg.

These inferences are confirmed by the absence of evidences of the action of land ice in the country on both sides of the river south of this point. From Riegelsville, near the mouth of the Musconetcong River, we drove to Bursonville, several miles out over the Triassic plateau which there extends beyond the Archæan outcrop, which rises several hundred feet on the south of the Lehigh, and where, if there had been any southern transportation by land ice, the remains would be most likely to be seen. But there was not the least sign of foreign material to be found. We drove out on both sides of the river at Lambertville, some distance down toward Trenton, with the same result. Professor A. A. Wright drove from Flemington across Sourland Mountain with the same result.

Along the Delaware we found distinct terraces both of Trenton and Columbia gravels. At Riegelsville the Columbia was well developed in an extensive terrace, preserved in an ox bow of the valley at a height of 175 feet. It had all the characteristics of the Brick Clays and Red Gravel at Philadelphia and other places below.

In addition to these detours we took the ride along the North Pennsylvania Railroad, from Bethlehem to Philadelphia, which passes over Mesozoic deposits for a distance of 25 or 30 miles, and shows almost a continuous section of the surface soil. There is no foreign material in it or on it. The same is true in New Jersey in the sections shown on the railroad from South Plainfield to Flemington, and from Bound Brook to Trenton.

The deposits at Fallsington belong to the Columbia. They are related to the river level, and are not higher than those at Philadelphia. The occurrence of scratched stones in them simply teaches that floating ice can transport material without effacing all scratches. At Bridgeport, opposite Norristown, on the Schuylkill River, there

is a terrace scarcely 100 feet high. I very much question whether there are any "glaciated" pebbles in it. Certainly the whole country around through which we drove for a considerable distance, does not show signs of glacial action. I should say that the occurrence of scratched stones in that vicinity conclusively proves that such striation can be produced by other causes than glacial ice. The same is, perhaps, true of Professor Salisbury's other isolated cases at Bethlehem and Sunbury, and probably support my inferences concerning the deposits at High Bridge and Pattenburg.

The conglomerate boulders between Monmouth Junction and Deans are not over 100 feet above sea-level, and there is no higher land between them and the Delaware at Trenton. They may, therefore, easily have been floated into their present position during the flooded condition of the lower Delaware Valley, when the deposits of Philadelphia red gravel and brick clay (the Columbia) took place.

The facts already presented concerning the extension of glacial ice on the east side of the Delaware River for several miles south of Easton, furnish the key to the perplexing phenomena of the Lehigh Valley below Bethlehem. The fringe of glacial ice deposits extends southward to the vicinity of Easton, and westward to the divide between Bushkill and Monocacy creeks in the vicinity of Nazareth. The evidence is not yet as complete as I would like, but there is already enough to give a great degree of certainty.

It is significant that Monocacy Creek north of Bethlehem is perfectly free from pebbles—the natural reason being that it has its course over limestone and slate formations which furnished none. If these formations had been overrun by glacial ice, this would not have been the case. On the other hand, Bushkill Creek has them in abundance. The only difference between the creeks is that boulders had been scattered over the headwaters of the Bushkill by the ice, and not over those of Monocacy. That the ice extended nearly, at least, to the watershed between the creeks seems certain, from the fact that large boulders of Medina occur in considerable abundance on the slate hills two miles north of Nazareth, at a height of about 400 feet above the Bushkill.

The Lehigh, from the Gap to Easton, flows through or across the Hudson River Slates and Trenton Limestone, which so persistently border the Blue Ridge all along the Atlantic coast. For some reason, the surface of the limestone belt is pretty generally from 200

to 300 feet lower than the slate. Indeed the limestone is rarely more than 200 feet above the river. Hence it is within reach of the regular Columbia deposits. It is therefore difficult to tell whether the distribution of glaciated material over this area about Bethlehem and toward Easton was by direct glacial action or by the aid of water. The extension of the ice past the mouth of the Lehigh would indicate a good deal of disturbance in the drainage of the river, and I am inclined to recognize that agency in accounting for many of the facts. The terraces at Bethlehem are not over 200 feet above the river. If, however, it be true that Professor Salisbury has found glaciated pebbles 500 feet above the river on the mountain south of the city I should grant the extension of the glacier to that point. But such an extension seems to me improbable, from the lay of the land. The glacier which surmounted Blue Ridge at Offset Mountain, and in its retreat piled up the vast moraine at Ackermansville, may well have fanned out to cover the hills north of Nazareth, and it certainly deposited a moraine of considerable dimensions near Shimerville, about five miles north of Easton. But it seems unlikely that it could extend as far as Bethlehem, and since we have other causes in the field to easily account for all the facts that appear there, we need not make the supposition. Floating ice in a river valley gorged as this was both by bergs from the glacier further up, and by land ice at its mouth, is cause sufficient, and there is no need of asking for more.

The conclusion of the whole matter is:—1st, That on the Atlantic coast, as in the Mississippi Valley, there is usually a fringe of thinner glacial deposits extending a few miles more or less, south of any well defined moraine. 2d, That this fringe is limited in the east branch of the Susquehanna by Montour's Ridge at Bloomsburg. That all the higher glacial deposits below that point belong to the Columbian era, and do not extend anywhere much above 200 feet above the river, while at Harrisburg they are limited to about 130 feet. 3d, That in the Delaware Valley the ice extended about six miles past the mouth of the Lehigh, and for several miles northeastward was limited by Musconetcong Mountain, and then drew back to the rear of Pohatcong Mountain. Farther east, however, these mountains both come again into the range of the ice movement. 4th, That the lower part of the Lehigh was specially clogged with ice, so as to increase the floods for some distance up toward the Gap, but the ice

did not pass over South Mountain into the Triassic plain of Bucks County. 5th, That below this moderate fringe there is no evidence of direct glacial action, but every evidence against it, except possibly at High Bridge and Pattenburg. 6th, The important thing to do now is accurately to delineate the border of this fringe by the aid of the easily recognizable transported foreign material. Since last summer I have been able to determine the limit approximately a few miles south of Draketown, near German Valley, about half way between High Bridge and Dover. A few days' work would, I am confident, determine the line entirely across the State. 7th, The deposits mentioned by Professor Salisbury at Fallsington, in Pennsylvania, and at Monmouth and Kingston, in New Jersey, consist of material which has been distributed by the floods coming down the Delaware River, while those at High Bridge and Pattenburg possibly belong to the fringe, but more probably to movements connected with the secular disintegration of the gneissoid mountain core, at whose southern base they now lie. 8th, That the facts do not lend support to the theory of a discontinuity between the drift north of the moraine and that south of it. Instead of holding with Professor Salisbury that the drift under discussion has "not had any genetic connection with the moraine, or any time relation to it, except one of great separation" (N. J. Ann. Rep. for 1891, p. 105), we should hold that it had both a genetic connection and a moderately close time relation. It is not true that the extra-morainic drift is, as Professor Salisbury says, "composed of materials which are, in some measure, inherently unlike those which compose the moraine." The drift material is essentially the same. The material in it "inherently unlike those which compose the moraine," comes from the gneissoid rocks with which it is mingled, and which have been undergoing disintegration for untold ages. The "advanced stage" of "oxidation, leaching, disintegration," apparent at Little York and the other places mentioned by Professor Salisbury, is plainly due to preglacial, rather than to postglacial influences. We cannot, therefore, with him hold "that this extra-morainic drift represents the remnant of a drift-covering once more extensive and more uniformly present than now, and that, . . . it was formed . . . by an ice sheet which overspread New Jersey much earlier than that which made the terminal moraine, and the main body of drift which lies north of it." (N. J. Ann. Rep. for 1891, p. 105.)

The following annual reports were read and referred to the Publication Committee:—

REPORT OF RECORDING SECRETARY.

The Recording Secretary respectfully reports that the meetings of the Academy have been held without intermission throughout the year, a sufficient number of members being present every Tuesday evening, even through the mid-summer months, for the transaction of scientific business.

The average attendance has steadily increased, amounting during the twelve months from Dec. 1, 1891, to Nov. 30, 1892, to 64 as compared with 52 in 1891, and 30 in 1889. This satisfactory result has been due in part to the interest felt in the ordinary verbal communications made at the meetings, but in a measure to the extraordinary attendance secured by issuing postal card notices of events somewhat distinct from the routine work of the Academy. Among these may be mentioned an illustrated address on the exploration of Labrador by Mr. Henry G. Bryant, a paper by the President on the extent of the coal supply of the world and the possible consequences of its exhaustion, an account by the Rev. Mr. Nassau of the character, habits and mode of capture of the gorilla, and the report by Lieutenant R. E. Peary of the results of his Greenland exploration.

The attendance on these occasions varied from 137, who listened to Mr. Nassau's paper, to 922, who were present when Lieutenant Peary made his report. In addition to these, and in many cases not of less importance, communications have been made by Messrs Allen, A. P. Brown, Calvert, Chapman, Cope, Dixon, Foote, Goldsmith, Hay, Heilprin, Holman, Ives, Koenig, McCahey, McCook, Martindale, Pilsbry, Rand, Rex, Ryder, Sharp, Willcox and Woolman.

Ninety-seven pages of the Proceedings for 1891, illustrated by 3 plates, and 325 pages for 1892, illustrated by 13 plates, have been issued. The third part of the ninth volume of the quarto journal, consisting of 159 pages and 8 plates, has also been published and distributed to subscribers and exchanges. The Conchological Section has continued the publication of the Manual of Conchology,

two volumes in continuation of the first and second series of the work, devoted respectively to Marine Univalves and Pulmonata, having been completed. They consisted of 420 pages and 126 plates. During the same time the Entomological Section has distributed 268 pages and 10 plates of the "Entomological News," and 307 pages with 16 plates of the Transactions. As it is through its publications the Academy is brought into communication with the scientific world, the record of its activity in this department during the past year is most gratifying.

Twenty-four papers have been presented for publication as follows:—H. A. Pilsbry 4, Edw. D. Cope 3, J. E. Ives 2, William B. Scott 2, Thomas Meehan 2, William J. Fox 1, Isaac J. Wistar 1, Carl H. Eigenmann and Rosa S. Eigenmann 1, Henry C. Chapman 1, A. P. Brown 1, Witmer Stone 1, Henry Skinner 1, John A. Ryder 1, Horace A. Hoffman 1, Ernest Walker 1, and Edw. L. Green 1. One of these was returned to the author, one was withdrawn by the author, and the others have either been published or are in the hands of the printer. The greater number of communications made verbally at the meetings have been reported by the authors and printed in the Proceedings.

The edition of the Proceedings of the Academy is 1,000 copies, 90 of which are sent out to subscribers, and 500 to exchanges. Of the Journal 500 copies are printed, 37 are sent to subscribers and 50 to exchanges.

It is again necessary to urge the desirability of greatly enlarging the Publication Fund so as to enable the Publication Committee to secure prompt issue, with creditable illustrations, of all worthy communications presented to the Academy. Our obligations to our correspondents increase yearly, and the liberal exchanges for which, as will be seen by the Librarian's report, we are indebted to kindred societies throughout the world, still constitute the chief and by far the most important additions to our library. In this exchange of the results of brain-work, the Academy cannot afford to be on the debtor side of the account.

Sixty members and six correspondents have been elected, an important increase in the former over the accessions of recent years. The deaths of ten members and of three correspondents have been announced and recorded in the published Proceedings. The following members have resigned:—Otto Luthy, Minford Levis M. D., Robert Meade Smith M. D., Henry Hartshorne M. D., W.

S. Auchinchloss, E. F. Smith, H. LeBarre Jayne, S. N. Rhoads and Mrs. E. L. Head. The actual increase in membership, therefore, at the end of the year is forty-one.

The departure of the expedition for the relief of Lieutenant Peary, and its return, Sept. 23, accompanied by the exploring party which had been left at McCormick Bay, July 30 of the preceding year, were the events in the current history of the Academy which attracted most popular attention and interest. The details of the enterprise, the success of Lieutenant Peary and his associates, and of the party which went to their relief under the direction of Professor Heilprin, have been reported to the Academy. It is gratifying to be able to record that the work of investigating the geography of Northern Greenland and the region beyond, so ably carried on by Lieutenant Peary, will in all probability be continued by him during the coming year, as on the application of the President of the Academy, he has been granted leave of absence for that purpose by the Navy Department.

The new lecture hall of the Academy, an important addition to the educational facilities of the society, was transferred by the Board of Trustees of the Building Fund, Feb. 23. The usual Friday evening lectures are delivered in it. Its use was granted to Professor Rothrock for the delivery of the Michaux forestry lectures, and several of the meetings of the Geographical Club, a society in close affiliation with the Academy, have been held therein.

In response to an application from the State Board of Health, Dr. S. G. Dixon was appointed March 8th as the representative of the Academy to act in conjunction with the Board in making a bacteriological exhibition at the coming Columbian Exposition in Chicago. It is gratifying that the society is thus to be associated with a representation of a branch of original research which is certainly second to none in the practically beneficial results to be derived from its cultivation.

Mr. Jacob Binder was re-appointed Curator of the William S. Vaux collections. As Mr. Binder has been, during a portion of the year, unable in consequence of failing health to discharge the duties of the position, Mr. W. W. Jefferis was appointed as his associate. The growth of the collections under their charge is recorded in the special report prepared by Mr. Jefferis.

The Hayden Memorial Medal and fund has been awarded to Professor Eduard Suess of Vienna, the importance of whose geological work fully merits the recognition recommended by the Academy's Committee.

The resignation of Dr. George A. Koenig from the Council, in consequence of his removal to the West, was received and accepted with regret. By resolution of the Academy, the election to fill the vacancy was deferred until the annual meeting.

All of which is respectfully submitted.

EDW. J. NOLAN,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

The Corresponding Secretary respectfully reports that during the year commencing December 1, 1891, he has received one hundred and fifty-one acknowledgments of the receipt of the publications of the Academy from eighty-one Societies, Museums, etc., and seventy-eight notices of the forwarding of their own publications from sixty-one Societies, etc. There has been received fifteen applications to exchange publications and asking for missing numbers of the Academy's Journal and Proceedings and three notifications to discontinue exchange. In addition, thirty-two letters on various subjects have been received and seventeen written. Nine circulars and five invitations to the Academy to participate in congresses, meetings, etc., have been received and answered. Six notices of deaths have been recorded.

During the year six correspondents have been elected, and notices to that effect have been forwarded. The deaths of three correspondents have been reported. Twenty-five certificates have been sent to members and six to correspondents.

One thousand three hundred and nine acknowledgments for gifts to the library, and two hundred and twenty-five for gifts to the Museum have been forwarded.

Respectfully submitted,

BENJAMIN SHARP,
Corresponding Secretary.

REPORT OF THE LIBRARIAN.

I have pleasure in reporting that the statistics of the library during the twelve months from Nov. 30, 1891, to Dec. 1, 1892, indicate a steady increase in the rate of growth in this department of the Academy. The number of accessions amount to 6,111. This includes 1,108 volumes forming the John Warner library, to be referred to later. Exclusive of this special gift, the current accessions include 4,556 pamphlets and parts of periodicals, 413 volumes and 34 maps, making a total of 5,003, as compared with 4,335 of the preceeding year.

They were derived from the following sources:—

Societies,	2,302	Geological Survey of Texas,	3
I. V. Williamson Fund,	1,014	East Indian Government,	3
Editors,	939	Benjamin Sharp,	3
Authors,	199	Bentham Trustees, Kew Garden,	3
U. S. Department of the Interior,	142	Department of Mines, N. S. W.,	2
Wilson Fund,	75	Rev. D. B. McCartee,	2
Thomas Meehan,	42	Ohio State Board of Agriculture,	2
Geographical Survey of Mexico,	29	Geological Survey of New York,	2
U. S. Department of Agriculture,	26	Australian Government,	2
Charles P. Perot,	24	Geological Survey of Missouri,	2
H. C. Chapman,	15	Geological Survey of Arkansas,	2
Geological Survey of Russia,	14	Ohio State Board of Agriculture,	2
U. S. Department of State,	14	Pennsylvania State Board of Health,	2
Pennsylvania State Librarian,	14	Trustees of East Indian Museum,	2
Minister of Public Works of France,	13	Smithsonian Institution,	2
Henry M. Fisher,	10	W. H. Dall,	1
U. S. Treasury Department,	8	Missouri Botanical Garden,	1
Geological Survey of India,	8	C. C. Febiger,	1
Geological Survey of Finland,	6	Illinois Department of Agriculture,	1
H. A. Pilsbry,	6	Geological Survey of New Jersey,	1
Angelo Heilprin,	4	H. G. Ives,	1
Geological Survey of Alabama,	4	W. J. Fox,	1
Tennessee State Board of Health,	4	Department of Mines, Nova Scotia,	1
Geographical Survey of Canada,	4	G. E. Frisby,	1
State Entomologist of Illinois,	3	Massachusetts State Board of Agriculture,	1
U. S. Lighthouse Board,	3	T. H. Morgan,	1
U. S. War Department,	3	Geological Survey of Portugal,	1
British Museum,	3	Geological Survey of Minnesota,	1
Charles E. Smith,	3	Norwegian Government,	1
Geological Survey of Kentucky,	3	Geological Survey of Indiana,	1
U. S. Coast Survey,	3	E. J. Nolan,	1
Geological Survey of Pennsylvania,	3		

Meteorological Service of Canada	1	Robert Walton,	1
Iowa Agricultural College,	1	Minister of Works, Mexico,	1
Prof. James Hall,	1	Russian Government,	1
Charles M. Betts,	1	S. G. Dixon,	1
Department of Labor,	1	Henry Skinner,	1
Navy Department,	1	J. H. Redfield,	1
H. B. M. Government,	1		

They were distributed to the departments of the library as follows:—

Journals,	4,060	Helminthology,	19
Geology,	193	Ornithology,	12
Botany,	138	Herpetology,	12
General Natural History,	90	Encyclopedias,	1
Entomology,	65	Mammalogy,	9
Anatomy and Physiology,	57	Chemistry,	9
Conchology,	35	Agriculture,	8
Physical Science,	30	Medicine,	6
Voyages and Travels,	29	Bibliography,	5
Mineralogy,	27	Ichthyology,	5
Anthropology,	22	Geography,	2

One hundred and sixty accessions were on subjects foreign to the Academy's interests and remain unclassified.

Mr. John Warner, who died in July 7, 1873, bequeathed to the Academy his library. It consists of 1,045 volumes, and upward of 1,200 pamphlets, forming 63 additional volumes, for the most part on pure mathematics, physical science and engineering. The will was made within one month of Mr. Warner's death, the Academy, therefore having been adjudged by the Courts a public charity, could not inherit nor could the books be otherwise conveyed to the society until the coming of age of Mr. Warner's infant daughter, who on attaining her majority, signified her wish that her father's desire should be complied with.

The books have therefore been conveyed to the Academy as the gift of Mrs. Anna L. and Miss Lydia Warner in harmony with the wishes of the husband and father. The library is specially rich in works of the last century on pure mathematics, and forms a valuable addition to the Academy's bibliographic wealth. It has been arranged in one of the alcove rooms.

Having been again enabled by friends of the Academy to avail myself during the summer and autumn of the services of Signor E. Fronani, he has been employed the greater part of the time on the arrangement and cataloguing of the Warner library, a work

which otherwise could not have been so promptly performed because of the want of available clerical assistance. Author and subject card catalogues of the collection have been completed, while an author catalogue has been prepared for the pamphlets, which have been arranged in 63 volumes ready for binding.

Two hundred and thirty-five volumes have been bound, including Andubon's elephant folio work on the Birds of North America, the plates of which have been carefully cleaned and backed with linen. A special case for the reception of this work has been ordered and will be so constructed as to permit the volumes to be placed flat, an arrangement which has been found by experience to be desirable for their preservation from injury. There is still need of a much larger annual appropriation for binding than the Academy has heretofore been in a position to make.

In the current work of the library I have received satisfactory assistance from Mr. William J. Fox, to whose usual duties has been added that of promptly acknowledging gifts and exchanges from societies and individuals.

All of which is respectfully submitted.

EDW. J. NOLAN,
Librarian.

REPORT OF THE CURATORS.

The yearly reports of the Curators, (the late Professor Leidy being their Chairman) during the last decade, state substantially that the collections in the museum were properly arranged and cared for. Mr. Charles F. Parker, then Curator-in-Charge, said in his report for the year ending November 30, 1882, that "the various collections have been carefully examined, and are in good condition." He died September 27, 1883. Professor Angelo Heilprin was elected in his place October 2, 1883.

In his report for the year ending November 30, 1883, he stated, in substance, that the condition of the museum though not "absolutely satisfactory, is yet fairly good when compared to the condition of similar collections in this country, or even of those pertaining to foreign institutions."

In all his subsequent reports, including that for the year ending November 30, 1891, he states that all the collections are in "good," or in "satisfactory" condition.

April 1, 1892, although requested by his fellow-curators to retain it, Professor Heilprin resigned the office of Curator-in-Charge, which he had continuously filled during eight years and a half, it is believed, with general approval.

His colleagues then determined to take care of the Museum as an executive body without compensation. They agreed that the senior of the Board should be the Director, and that Professor Dixon should be his representative and the executive Curator.

A careful examination of the premises, which the by-laws place in charge of the Curators, was at once begun, and continued throughout the year. Drs. Dixon and Chapman have given much time and labor to rectifying whatever they considered to be in need of correction.

Professor Heilprin did not take part in the work, because about the time of his resignation, he was fully occupied preparing to lead a party to relieve Mr. R. E. Peary, who under the auspices of the Academy, started last year, suitably equipped and accompanied, on an exploring expedition in Greenland. Both parties safely returned September 24th. Prof. Heilprin at once resumed his office of Secretary of the Board of Curators, and devoted much time and labor in properly disposing of and arranging the mass of material brought to the Academy by the two expeditions to Greenland.

The Curators began their work in the cellar. They found some valuable specimens and much rubbish. It is supposed that, in the course of the decade, those specimens were placed there to remain only till space in the museum for their proper exhibition should be found.

Rooms in the cellar for the use of the taxidermist, one for the storage of duplicate specimens ready for exchange, and another for spare shelves, lumber, etc., were suitably appropriated.

Many specimens found astray in library-rooms were properly placed in the museum. A room in the library is in course of preparation as the office of the Curators, in which will be aranged all papers, correspondence, etc., pertinent to their duties.

In the museum were found some specimens misplaced, some in a decaying state and a few quite ruined. Dozens of skulls, which were covered with a destructive growth, were cleaned and sterilized.

The skilful taxidermist of the Academy, Mr. D. N. McCadden, has remounted all the mammals, and repaired several valuable

specimens. The birds of North America have been remounted, and many duplicates withdrawn.

The wet preparations, especially those of reptiles and fishes, have been placed in fresh alcohol.

The positions of some of the cases in the museum have been changed, making, as is supposed, inspection of their contents more satisfactory.

Specimens on the walls of the main stairway to the museum have been re-arranged and labelled. The archæological collection has been concentrated, and the Vaux collection of minerals is now daily open to visitors.

Air-tight dark cases for the preservation of duplicate mammal and bird-skins have been provided, and a germicide has been placed in all cases containing organic preparations.

Many specimens loaned but not duly returned have been recovered.

At different times during the year the Curators have received valuable assistance from Professors Cope, Ryder and Allen in identifying certain species of reptiles, fishes and bats among the wet preparations.

The labor of the Professor of the lower vertebrata during the year is notable. He has re-labeled and numbered 403 trays and bottles containing specimens of 178 species and varieties of 56 genera in the carcinological collection, and prepared a complete catalogue of the same.

Lack of space for suitable arrangement and satisfactory exhibition of our great collections has existed many years. This need will be supplied in the course of the next year. The erection of an additional building, now in process of construction, will add about 30,000 square feet to the floor space of the museum. For a large part of the means to enable the Trustees of the building fund to do this work, it seems proper to mention here that the Academy is very much indebted to the ability and steadiness of purpose of Professor Heilprin, who several times visited Harrisburg, and by his representation to members thereof, greatly contributed to satisfy the Legislature of Pennsylvania of the worthiness of the Academy to receive pecuniary assistance from the State. Possibly, without the influence of his intervention, appropriations might not have been granted at the time.

An account of special collections in the immediate care of the Sections or Professors of the Academy is not offered here as it is properly a part of their annual reports. It is believed that all the collections are in good condition.

Lists of the additions to the museum during the year will be appended, including those procured in Greenland by Professor Heilprin with means supplied by the Academy.

Respectfully submitted,

W. S. W. RUSCHENBERGER,

Chairman of the Curators.

REPORT OF THE BIOLOGICAL AND MICROSCOPICAL SECTION.

This section has held during the year 1892, nine meetings exclusive of those in conjunction with the Academy.

The membership has been increased by one new member, and one name has been added to the list of contributors.

Many interesting communications have been made, the more important of which are:

On Actinomyces bovis, by Dr. S. G. Dixon.

A peculiarity in the skull of a Bat, by Dr. Harrison Allen.

Young of Baculites, by Mr. A. P. Brown.

Syphoptychium and Tubulina, by Dr. G. A. Rex.

Films of metallic Gold, by D. S. Holman.

Hippa, by Dr. Benjamin Sharp.

Pinnotheres, by Dr. Benjamin Sharp.

Joint formation among the Invertebrata, retiring address of Director Benjamin Sharp.

Additions to the property of the Section have been made as follows:

By purchase—One Spencer ⅛ inch objective.

—Two "B" eye-pieces.

By donation—One $\frac{1}{10}$ inch objective, from Mr. A. P. Brown.

One Centennial Microscope from the heirs of Dr. R. S. Kenderdine.

About 600 slide preparations from the heirs of Dr. R. S. Kenderdine.

About 45 slide preparations from Mr. Harold Wingate.

About 50 slide preparations from Dr. George A. Rex.
About 25 slide preparations from other members.

The officers for the ensuing year are :—

Director, ...	Mr. A. P. Brown.
Vice-Director, ...	Mr. Jno. C. Wilson.
Recorder, ...	Mr. Harold Wingate.
Treasurer, ...	Mr. Chas. P. Perot.
Corresponding Secretary, . . .	Dr. Chas. Schäffer.
Conservator, ...	Dr. Geo. A. Rex.

Respectfully submitted,

HAROLD WINGATE,
Recorder.

REPORT OF THE CONSERVATOR OF THE CONCHOLOGICAL SECTION.

Since the last annual meeting of the Conchological Section, specimens have been received from thirty persons; the entire number of trays added to the museum being 1,150, a detailed list of which is hereto appended.

A valuable accession to the museum during the year is the collection of mollusks both dry and alcoholic, dredged in Greenland waters, by Professor Angelo Heilprin, of the Peary Relief Expedition. Although they have not yet been studied, the writer has ascertained the presence of a number of species not before in the collection of the Academy, of the genera *Margarita*, *Buccinum*, *Sipho* and other Arctic groups. The specimens being preserved in alcohol, are in excellent condition for the examination of the soft parts.

Various correspondents of the Conservator have supplied a considerable number of our desiderata in United States mollusks; but the greater number of additions from this country have been through the American Association of Conchologists. The special exhibit of American mollusks, being formed by this Association, has been increased during the year by 443 trays, representing nearly that number of species. The total number of trays now in this American exhibit is 1,510, representing 730 recent and 425 fossil species.

From Messrs G. E. and A. H. Verrill, we have received several rare species from Dominica, W. I., and from Professor José N.

Rovirosa, a valuable collection of land and fresh-water shells from the State of Tabasco, Mexico, including a number of new forms; a list of these, with descriptions and illustrations of the new species, is published in the Proceedings of the Academy.

The more valuable accessions from Australasia, have been the series of New Zealand Chitons, received from Professor F. W. Hutton, of Christchurch, N. Z.; the New Zealand gasteropods, lamellibranchs and brachiopods, received from Mr. G. W. Wright, of Auckland, N. Z.; and a series of 34 selected species of Australian gasteropods from Mr. Billinghurst, for which the same number of American shells were sent in exchange.

From Dr. O. F. v. Möllendorff, of Manila, Philippine Islands, 35 species of land shells, new to our collection, being with a few exceptions, his own new species. Also a series of 20 Oriental Helices in alcohol, for dissection.

In the museum the land shells have been remounted and systematically arranged, as far as they have been monographed in the last completed volume of the Manual. The arrangement of the marine gasteropoda is also practically completed as far as the Chitons, the study of which has not been finished.

Four cases fitted with shallow trays in lieu of drawers, have been supplied by the Curators of the Academy, affording space for the systematic arrangement of the limpets and chitons. It is hoped that equal facilities for the accommodation of the Bulimi will be provided during the coming year.

The Conservator has received much assistance during the year from Messrs Campbell, Johnson and Ford; these gentlemen having re-arranged the cases containing fluviatile gasteropods, which have been inconveniently over-crowded for several years past. The entire work of determining, labelling and mounting the specimens of the American Association collection has also been performed by the same gentlemen.

Respectfully submitted,

H. A. PILSBRY,

Conservator.

REPORT OF THE ENTOMOLOGICAL SECTION.

During the year, ten meetings have been held, with an average attendance of ten persons; the largest number present at a meeting being thirteen, and the smallest eight. The meetings have been interesting and instructive, verbal communications on entomological subjects having been made by nearly all the members and associates. Three new members have been elected and two associates. Considerable work has been accomplished in the re-arrangement and care of the collections by the Conservator and some of the members, and about twenty-two hundred specimens have been added to the cabinets; this does not include a thousand or more received through "Entomological News" to be named. Among the most noteworthy additions were 845 Mexican Coleoptera, presented by Dr. Horn; types of Tachinidæ, by C. H. T. Townsend; the Stone collection of spiders, 160 species in 400 vials, by Mr. Witmer Stone; types of Jassidæ, by E. P. Van Duzee; 35 species of Aculeate Hymenoptera, by Charles Robertson; a collection of Japanese and Indian Lepidoptera, presented by Mrs. L. Stevens through Dr. H. C. McCook; American and European Odonata presented by P. P. Calvert and the insect collection brought home by the Peary Relief Expedition. The Section has published during the year Vol. 3, of the Entomological News, with the financial aid and encouragement of the American Entomological Society. The volume closed with 268 pages and ten plates. The journal will be continued with 32 or more pages a month, and will be regularly illustrated. It is now just double the size of Vol. 1, which contained 16 pages per month, and no illustrations. It is the only regularly illustrated entomological journal in the world.

At the last meeting, on December 12th, the following were elected to serve as officers for the ensuing year:

Director,	Geo. H. Horn.
Vice-Director,	I. C. Martindale.
Conservator,	Henry Skinner.
Recorder,	Henry Skinner.
Treasurer,	E. T. Cresson.
Publication Committee,	J. H. Ridings, Philip Laurent.

HENRY SKINNER,
Recorder.

REPORT OF THE BOTANICAL SECTION.

The Vice-Director of the Botanical Section respectfully reports that the Section is wholly free from debt, and that the monthly meetings have been regularly held, except during the three summer months. Besides the valuable additions to the library and herbarium of the Academy, announced at each meeting, many interesting addresses have been given by Messrs Meehan, Redfield, Macfarlane, Brinton, U. C. Smith, Wilson, Martindale and others, some of which have been published, or will appear, in the Proceedings of the Academy.

The membership now consists of 32, and the officers elected for the ensuing year are:

Director, ...	Dr. W. S. W. Ruschenberger.
Vice-Director, ...	Thomas Meehan.
Recorder, ...	Dr. Charles Schäffer.
Cor. Secretary and Treasurer,	Isaac C. Martindale.
Conservator, ...	John H. Redfield.

It is a pleasure to note that under the zealous and unremitting care of the Conservator, Mr. Redfield, the growth of the herbarium noted annually for some time past, is not only maintained, but exceeds that of any previous year. No less than 3,934 species have come to hand, nearly equally divided between the Old and the New World, and of these 2,087 were species new to the herbarium.

A list of these contributions is given in detail by the Conservator, and will be found in the list of additions to the museum.

THOMAS MEEHAN,
Vice-Director.

Report of the Conservator.—In presenting his report for the year now closing, the Conservator of the Botanical Section has the satisfaction of stating that in no previous year have the contributions to it been larger or more valuable. With the increased accommodation which we may hope soon to enjoy, we have every reason to expect a continued, substantial and healthy growth of a collection so important to the study of systematic and practical botany.

The contributions during the past year reach a total of 3,934 species. Of these, 284 belong to the lower Cryptogams, 80 being Mosses, 57 Hepaticæ, 16 Lichens, 2 Algæ and 129 Fungi. Of the remaining 3,650 species of Phanerogams and Ferns, 1,269 proved to

be new to the herbarium, 39 of them being of newly represented genera. Of these 3,650 species, 294 are North American, 1,269 are Mexican and South American, and 2,087 are from the Old World.

The usual detailed statement of the contributions will appear in the list of additions to the museum. In specifying here some of the more important, the first place must be given to the very large accession to our representation of the Orient Flora, in the plants collected by Bornmüller and Sintenis, in Greece, Macedonia, Asia Minor, Armenia, Kurdistan and Mesopotamia, and purchased for the Academy by the liberality of Mr. Charles E. Smith and a few other friends of botanical science. These amount to 1,226 species, of which 567 are new to us. Dr. Morong's collections in Paraguay, sent us during the year, amount to 459 species, more than half being new to us. Pringle's Mexican collections, made in 1891, are of the same carefully selected and well prepared specimens as heretofore, and reach 266 species, 125 being new to us. Our faithful correspondent, Mr. T. S. Brandegee, of San Francisco, has sent us 268 species from the peninsula of Lower California, of which nearly one-half are novelties to us. From the University of Pennsylvania we have received 148 species, collected by Dr. Joseph T. Rothrock in Jamaica and the Bahama Islands, in his voyage made in the winter of 1890 and 1891. Mr. Meehan has presented us with another instalment of Baron von Müller's Australian plants, amounting to 135 species.

These additions have all been properly mounted and distributed to their proper places in the herbarium. The labor and time demanded by this work, have prevented much progress in the mounting of the older portions of the herbarium, yet something has been done in this direction, and the work will be continued as opportunity may permit.

The botanical collections made in Greenland by the Peary Relief Expedition, Mr. William E. Meehan, botanist, during the past summer, are still under study; they will be included in the report of next year. Mr. Stewardson Brown, who so carefully studied the collections made by Dr. Burk during the expedition of 1891, is engaged upon those of 1892, and reports that the specimens are in much better condition than those of the former year, the circumstances attending the collection having been much more favorable.

Respectfully submitted,

JOHN H. REDFIELD,

Conservator.

REPORT OF THE MINERALOGICAL AND GEOLOGICAL SECTION.

The Director of the Mineralogical and Geological Section of the Academy, would respectfully report that meetings of the Section with the Academy have been held regularly every month during the year, besides other meetings of the Section.

One hundred and four specimens of minerals and rocks have been presented during the year by twenty individuals.

The special feature of the year has been a series of excursions by the Section to various points of mineralogical and geological interest in the vicinity of Philadelphia. These have been most successful; the attendance has ranged from twenty to upward of fifty. The interest manifested has been great, and it is hoped that many young persons have been influenced toward the study of minerals and rocks. These excursions have been without expense to the Section, except for stationery, etc.

Some members of the Section, with the Conservator, and with the assent of the Curators, are engaged in rectifying the labels of the specimens in the Academy's collection, quite a number of which were found to have either wrong localities, or localities too indefinite.

Respectfully submitted,

THEO. D. RAND,
Director.

REPORT OF THE ORNITHOLOGICAL SECTION.

During the past year much important work has been accomplished in the re-arrangement of the Ornithological collections, and they are now in an excellent state of preservation.

The renovation of the exhibition collection of birds has been begun in accordance with the plan outlined in last year's report, and with the assistance of the Academy's able taxidermist, Mr. D. N. McCadden, very satisfactory progress has been made.

The collection of North American birds has been entirely remounted on walnut or stained stands, and re-labelled in accordance with the American Ornithologists' Union check-list, while the habitat of each species also appears on the label, which will prove of material aid to those who consult the collection. The whole

number of specimens contained in this collection is over 1,400, representing upward of 600 species and sub-species of North American birds. Many of the specimens needed to render the collection complete are contained in the study series of skins, and examples of these will be mounted during the ensuing year.

The collection of Ostriches and Apteryges has also been thoroughly renovated during the year, and the specimens of Tyrant Flycatchers in the museum, numbering about 450, have been identified and catalogued, representations of all the principal forms having been remounted and the duplicates reduced to skins for the study series.

Any further work in this direction, however, is rendered impossible by the lack of suitable cases of drawers in which the collection of skins may be safely preserved. All the available space is now crowded, and it is absolutely impossible to find accommodation for the additions that are being received. In view of the importance of this need, it is to be hoped that the necessary cases will soon be supplied.

The study collection of skins, now numbering about 6,000 specimens, has at last been catalogued and entirely re-labelled, which adds greatly to its usefulness. Over 3,000 specimens have been catalogued and labelled during the past year. For valuable assistance in this connection the Conservator is indebted to Mr. Samuel Wright.

The collection of birds' eggs has also been temporarily rearranged, and the North American specimens separated and re-labelled. Many valuable ornithological specimens have been received during the year.

Foremost among these is a collection of 46 Arctic birds, secured by the North Greenland Expedition, and a collection of 76 specimens brought back by the Peary Relief Expedition. These together with the Arctic birds secured by the West Greenland Expedition of 1891, form probably the finest collection of Greenland birds in this country.

The Delaware Valley Ornithological Club has continued to add to the beautiful series of nests and eggs of Pennsylvania and New Jersey birds which was presented last year, and the collection has doubled in size, containing at the present time, 80 nests and sets of eggs. Quite a number of groups of birds have been prepared to accompany the nests, which serve to render the collection more attractive and instructive. The Philadelphia Zöological Society has presented numerous valuable birds, which have been mounted

or preserved as skins, and further donations have been received from Dr. S. G. Dixon, I. N. DeHaven, D. N. McCadden and others.

It is gratifying to note the increased interest in Ornithology among the members of the Academy, due to the efforts of the Section and the Delaware Valley Ornithological Club, as well as the appreciation by the visiting public of the improvements and additions in the Ornithological departments of the museum.

At the annual meeting of the Section, held December 19th, 1892, the following officers were elected for the ensuing year:

Director, ...	Spencer Trotter, M. D.
Vice-Director, ...	George Spencer Morris.
Recorder, ...	Stewardson Brown,
Corresponding Secretary, . . .	Charles E. Ridenour.
Treasurer, ...	Isaac C. Martindale.
Conservator, ...	Witmer Stone.

Respectfully submitted,

WITMER STONE,
Conservator.

REPORT OF THE PROFESSOR OF INVERTEBRATE PALEONTOLOGY.

The Professor of Invertebrate Paleontology respectfully reports that owing to his participation in the organization and accomplishment of the Peary Relief Expedition—a duty with which he was entrusted by the Council of the Academy and the Academy—he has been able to give but little, in fact, scarcely any, attention to his department during the past year. It is believed, however, that this deficiency in attention has been more than compensated by the valuable collections which have resulted from the Greenland Expedition, and which touch largely the departments of geology and paleontology. Of such collections may be mentioned the series of blocks of Ovifak iron, the fossils of the elevated terraces of Greenland, the fossil fishes from Ameralik Fjord, and above all the extensive series of Cretaceous and Miocene plant remains from Atanekerdluk. The fossil fishes, the first of the class that have been obtained in the region, are but few in number, but advice from one of the Governors of South Greenland, under date of September 17th, indicates that a box-full has been directed to the

Academy; doubtless this supplemental collection will be received in due time. Only a part of the Arctic collections has been thus far classified and labeled, the present limitation of space in the Academy's working rooms rendering the process of arrangement a laborious one.

Among other valuable additions to the department made during the year are an extensive series of Tertiary fossils from the Atlantic and Gulf borders of the United States, for which the Academy is indebted to Mr. Joseph Willcox; a collection, comprised in 89 trays, of sub-Carboniferous crinoids from the Burlington Group, purchased by the Curators from Mr. F. L. Sarmiento; and an interesting series of Cambro-Silurian fossils, presented by the late Dr. J. P. Lundy, from the region of Lake St. John, Canada.

No relief to the crowded condition of the Academy's collections in the department of invertebrate paleontology has thus far been found possible, and probably no marked change in this direction will be effected until the occupancy by the Academy of the new building, which is now in course of erection.

No lectures in this professorial department have been delivered during the year, and the undersigned regrets his failure to finish the preparation of the course which had been intended for the autumn season, and upon which he hopes to enter during the coming month.

Respectfully submitted,

ANGELO HEILPRIN,

Professor of Invertebrate Paleontology.

REPORT OF THE PROFESSOR OF THE LOWER INVERTEBRATA.

The Professor of the Lower Invertebrata respectfully reports that during the past year he has delivered two lectures, one on "Greenland," and one on "Death from a Zöological Point of View."

The additions to the museum are noteworthy. They include the Crustaceans and Echinoderms collected by the West Greenland Expedition of 1891, together with twelve very fine specimens of *Antedon eschrichti*, (a crinoid), collected by the Peary Relief Expedition of 1892; a collection of Sponges from the Mexican Expedition of 1890, and sixteen jars of Echinoderms collected by William J. Fox in Jamaica.

There have been further presented about twenty-five species of Crustacea mainly from our coasts and from Jamaica.

During the year, work has been carried on almost exclusively in the carcinological collection, the specimens having been re-labeled and a catalogue prepared, which will be published in the next volume of the Proceedings. At present all the alcoholic and dried specimens of the Stomatopoda and Macroura have been examined as far as the Homaridea, and the dried specimens through the Loricata.

Respectfully submitted,

BENJAMIN SHARP,

Professor of the Lower Invertebrata.

REPORT OF THE CURATOR OF THE WILLIAM S. VAUX COLLECTIONS.

Owing to the continued illness of the Curator of the "William S. Vaux Collections," Mr. Jacob Binder, I am unable to state what additions he had made to the collection during the earlier part of the year, but since I have been acting as his assistant I have purchased 41 specimens of minerals, several of them being of special beauty.

The rooms have been constantly open to the public during the latter part of the year, an attaché of the Academy being in attendance, resulting, it is believed in an increased interest in the science of Mineralogy.

The collections are in good condition, but not in a suitable room for exhibition, as the minerals in the greater number of the cases can be seen only by gas light, which is to be regretted.

Respectfully submitted,

WM. W. JEFFERIS,

Acting Curator.

The Standing Committee of Council on By-Laws presented the following which was ordered to be printed:—

REPORT ON THE JESSUP FUND.

At a business meeting of the Academy, March 27, 1860, the following letter was read and referred to a special committee, of which Messrs. William S. Vaux, Joseph Leidy, Isaac Lea, Robert Bridges and Joseph Jeanes were the members:

PHILADELPHIA, March 6, 1860.

ISAAC LEA, ESQ., *President of the Academy of Natural Sciences of Philadelphia:*

DEAR SIR:—The undersigned, children of the late Augustus E. Jessup, believing that it was his intention to leave a sum of money to the Academy of Natural Sciences, for the purposes stated below, and desiring to carry out what we have cause to think were his intentions, propose to pay to the Academy the sum of one hundred and twenty dollars per annum, to be applied to its publication fund; and the further sum of four hundred and eighty dollars per annum to be used for the support of one or more deserving poor young man or men who may desire to devote the whole of his or their time and energies to the study of the natural sciences.

The above sums we propose to pay as long as we feel our circumstances to be such as will warrant our doing so, and we look forward to investing in trust, at some not distant time, the principal of the sums named for the purpose of creating a perpetual fund for the above named uses.

A. D. JESSUP,
E. A. JESSUP,
CLARA J. MOORE.

At a meeting of the Academy for business April 24, 1860, "the committee on the communication of Mr. A. D. Jessup, Mr. E. A. Jessup and Mrs. Clara J. Moore, presented a report accepting the trust, recommending that the President and Curators be constituted a perpetual committee under the direction of the Academy to carry out the intentions of the late Augustus E. Jessup as expressed in said communication; and that a copy of the publications of the Academy be presented to each of the above named children of the late Mr. Jessup, beginning with the volumes now in progress, which report was adopted and the committee discharged."

At the annual meeting of the Academy, Dec. 25, 1860, the committee on the Jessup Fund reported, July 1, that the first payment

was made, $60 to the publication fund, and $240 to the Jessup Fund.

William M. Gabb was appointed Jessup student from June 1, and C. C. Abbott from August 1, each to receive twenty dollars a month.

The rules for the administration of the fund, devised by the committee, were adopted as follows:

1. Applications for benefits from the Jessup Fund shall be made in writing to the committee (every three months).

2. Benefits from the fund shall not be received by the same person for a longer period than two years without the unanimous consent of the committee.

3. The beneficiaries shall devote one-half of their time, under the direction of the committee, to the study and management of the museum of the Academy.

4. Each beneficiary shall receive twenty dollars monthly by an order from the committee on the Treasurer.

Dr. Leidy, at the meeting of the Academy March 9, 1869, announced that the trustees of the Jessup Fund would receive applications of candidates for its benefits.

May 25, 1869, the Academy unanimously adopted a revised code of by-laws, in which, Chapter iv, Art. 1, it is enacted that "The Council shall determine who shall be beneficiaries of the Jessup Fund."

Since that date no legislation on the subject has been had.

From the date of acceptance of this trust until October, 1892, 54 young men and one young woman have been beneficiaries of the fund. Seven of the number have filled or are now filling professorial chairs satisfactorily.

Mrs. Clara J. Moore, November, 1888, generously added $5,000 to the fund. In a letter to the Chairman of the Committee on By-laws, August 19, 1892, she wrote: "As my father made no mention of young women, I prefer to give the same amount that he gave to be applied on the same terms to the support of one or more young women who may desire to devote the whole of their time and energies to the study of the natural sciences.

"While I think the amount of twenty dollars a month very little, I do not wish to influence in any way the decision of those who are more competent than I am to judge what the objections

may be to giving more, but I would suggest that thirty dollars should be the limit."

RULES FOR THE ADMINISTRATION OF THE JESSUP TRUST.

1. Candidates for the honor of a place on the list of Jessup students must be residents of the United States, of not less than 20 (twenty) nor more than 25 (twenty-five) years of age, and habitually resident within fifty miles of the Academy. But, on the recommendation of the Board of Curators, the Council may appoint a candidate who is less than twenty years of age.

2. The Board of Curators shall examine every candidate, and ascertain his age and place of birth; his moral and intellectual character; his worthiness in all respects of the honor of being appointed a Jessup student in the Academy of Natural Sciences of Philadelphia, in order that he may devote his whole time and energies to the study of the natural sciences under the directions of the curators of the Academy.

3. Every candidate who, after examination, may be favorably reported to the Council by the curators, may be appointed a Jessup student on probation during one month, and if the curators report that the probation has been satisfactory, the term will be extended to two years, and may be continued for two additional years at the discretion of the Council.

4. A Jessup student shall receive from the Jessup fund toward his support not more than twenty dollars a month, nor during more than four years.

5. No member of the Academy shall be a Jessup student, and no Jessup student shall be eligible to membership in the Academy.

6. Every Jessup student who has had the honor to satisfactorily complete a four years course of study in the Academy shall receive a certificate thereof, signed by the President and curators of the Academy.

7. Jessup students shall, in their studies and the occupation of their time, conform to such rules as the curators may prescribe from time to time.

8. Written applications to be admitted to the benefit of the Jessup Fund will be received at any time and considered by the Board of Curators.

The whole is submitted,

Very respectfully,

W. S. W. RUSCHENBERGER,

Chairman of Committee on By-Laws.

The election of Officers, Councillors and Members of the Finance Committee, to serve during the year 1893, was read with the following result:—

President, ...	Isaac J. Wistar.
Vice-Presidents, . . .	Rev. Henry C. McCook, D.D.
	Thomas Meehan.
Recording Secretary, . .	Edward J. Nolan, M.D.
Corresponding Secretary, .	Benjamin Sharp, M.D.
Treasurer, ...	Isaac C. Martindale.
Librarian, ...	Edward J. Nolan, M.D.
Curators, ...	W. S. W. Ruschenberger, M.D.
	H. C. Chapman, M.D.
	S. G. Dixon, M.D.
	J. T. Rothrock, M.D.
Councillors to serve three years, ...	Uselma C. Smith.
	Charles E. Smith.
	Geo. A. Rex, M.D.
	William Sellers.
Finance Committee, . .	Charles P. Perot.
	Charles Morris.
	Charles E. Smith.
	Uselma C. Smith.
	William Sellers.

ELECTIONS DURING 1892.

MEMBERS.

January 26.—James D. Winsor, H. H. Furness, Jr., Theodore P. Matthews, Thomas C. Price, Charles W. Johnson, Joseph W. Hawley, A. Jahn, James S. de Benneville, Charlemagne Tower, Jr., Joseph P. Remington, Charles Liebeck, Benjamin Chew Tilghman, J. E. Ives.

February 23.—Walter Horstmann, S. Emlen Meigs, John N. Hutchinson, Charles S. Boyer, A.M., Simon J. Martin.

March 29.—Frank Woodbury, M.D., H. G. Bryant, Lucy Langdon Williams, General John Markoe, Jean Fraley Hallowell, Daniel Allen Knight, Jr., Thomas Wistar, M.D.

April 26.—F. H. Giddings.

May 31.—J. F. Sachse, Henry Redmond, M.D.

June 28.—Francis M. Brooke, Henry Whelen, Hunter Ewing, C. A. Hamann, M.D.

August 30.—William Bringhurst, M.D.

September 27.—M. V. Ball, M.D., George S. Wolff, J. Liberty Tadd.

October 25.—John A. Shulze, George Vaux, Jr., Col. Ralph F. Cullinan, Thomas Earle White, Philip P. Calvert, Aldrich I. Pennock, George M. Woodward, Mary Vaux, Samuel Castner, Jr., John T. M. Cardeza, M.D., Ann May Whartenby, William L. DuBois.

November 29.—Charles Coulter, William DeCou, Henry C. Ford, William E. Meehan, Ann W. Pearsall, Mary Pearsall, William A. Shryock, Edward S. Scranton, Ellen W. Longstreth, Joseph G. Harrison, Edward Coles, William Wynne Wister, Jr.

CORRESPONDENTS.

February 23.—Howard Ayers, of Milwaukee, Wis.

March 29.—Karl Claus, of Vienna, Frederick Stearns, of Detroit, Mich.

May 31.—Edward J. Miers, of London, England.

August 30.—Carlos Berg, of Buenos Ayres.

November 29.—John Baird, of Manchester, C. Lloyd Morgan, of Bristol, England.

ADDITIONS TO THE MUSEUM.

1892.

ARCHÆOLOGY, ETHNOLOGY, ETC.

J. D. Winsor. Aboriginal implement from Islesboro, Maine.

C. B. Moore. Shells from Indian mounds of Florida.

J. P. Lundy, M. D. Shells from columns of temple of Jupiter Serapis, Puzzuoli, Italy, and piece of the floor of same; piece of mosaic from Lake Achelon, Italy.

Mexican Expedition 1890. Pottery from Cave of Calcehtok, Yucatan.

Miss Verhoeff. Eskimo Timiak from McCormick Bay, Greenland. Obtained by John M. Verhoeff on Academy's North Greenland Expedition, under Lieut. R. E. Peary.

MAMMALIA.

Zoological Society of Philadelphia. Mounted specimens of *Cynocephalus* sp., *Phacochœrus æthiopicus*, *Bison bison* (calf), *Solenodon cubanus*, *Belideus sciureus*, *Capromys pilorides*, *Cariacus rufinus*, *Cercocebus collaris*, *Ateles vellerosus*, *Ateles geoffroyi*, *Cercopithecus mona*, *Macacus radiatus*, *Macacus erythræus*, *Nyctipithecus trivirgatus*, *Sciurus badging*, (2 specimens), *Synetheres melanurus*, (2 specimens), *Macacus cynomolgus*, *Felis rufus*, (female and two kittens); mounted skeletons of *Cercocebus fuliginosus*, *Connochetes gorgon*, *Belideus sciureus*; disarticulated skeletons of *Semnopithecus entellus*, *Ateles vellerosus*, *Cariacus rufinus*, *Felis rufus*, *Helarctos eurypsilus*, *Solenodon cubanus*, *Nasua narica*; brain of *Cercocebus fuliginosus*.

Saml. G. Dixon, M. D. Horns of Indian Buffalo; mounted specimens of *Felis rufus*, Monroe Co., Pennsylvania; Opossum with three young; Eskimo dog "Alika" used on Lieut. Peary's North Greenland Expedition.

C. A. Bradenburg. Mounted specimen and skeleton of *Chrysothrix lunulatus*. skin of *Macacus erythræus*.

H. C. Chapman, M. D. Disarticulated skeletons of Orang-outang, Chimpanzee, Panther, Otter, Dog, Opossum, Howling Monkey, Marmoset, Porcupine, Rabbit, Armadillo, Prairie Dog; skulls of Deer and *Noctilio*; alcoholic specimens of Chimpanzee, Ring-tailed Lemur, Ant-eater.

H. G. Bryant. Skulls of *Lutra canadensis* and *Ursus americanus*, Grand River, Labrador; five Weasel and two Squirrel skins from Labrador.

Rev. R. H. Nassau. Three brains and skulls of the Gorilla, from Kangwe, Ogove River, West Africa.

Miss Virginia Maitland. Mounted specimen of *Scalops aquaticus*.

D. N. McCadden. Skull of *Ursus americanus*.

Benj. Sharp, Ph. D. Three alcoholic specimens of *Noctilio leporinus*, from Trinidad; and alcoholic specimen of *Vespertilio nigricans* and *Saccopteryx leptura* from Tobago.

Raymond Kester. Two mounted specimens of *Arvicola riparius* from Delaware Co., Pa.

Herbert Brown. Mounted specimen of *Vesperugo serotinus fuscus* from Philadelphia.

West Greenland Expedition, 1891. Skull of *Vulpes lagopus*, McCormick Bay.

Birds.

Philadelphia Zoological Society. Mounted specimen of *Rhea americana;* skins of *Crax fasciolaris, Grus americana, Xanthoura luxuosa cyanocapilla, Goura coronata, Phasianus reevesii, Eclectus roratus;* mounted skeletons of *Palamedea cornuta, Pelecanus fuscus;* disarticulated skeletons of *Grus australasiana* and *Grus americana;* egg of *Aquila maculata.*

Delaware Valley Ornithological Club. 17 nests, 18 mounted birds and 14 sets of eggs from Pennsylvania and New Jersey, to be incorporated in the "Delaware Valley Ornithological Club Collection."

Peary Relief Expedition, 1892. 76 bird skins representing 21 species, and 102 eggs representing 15 species, all from West Greenland.

North Greenland Expedition (Lieut. R. E. Peary in command.) 46 bird skins representing 17 species, from the vicinity of McCormick Bay, Greenland.

I. C. Martindale. Two skins of *Urinator imber*, from New Jersey.

I. N. DeHaven. Skin of albino *Ammodramus caudacutus*, Atlantic City, N. J.

H. C. Chapman, M. D. Skulls of *Rynchops, Gallus* and four other birds.

D. N. McCadden. Two skins of *Pelecanus fuscus;* eight skins of South American birds; skin of *Elanoides forficatus.*

H. Skinner, M. D., and Philip Laurent. Three skins, six nests and three sets of eggs of *Junco hyemalis carolinensis*, from Mitchell Co., North Carolina.

Samuel Wright. Alcoholic specimen of Chicken with four legs.

Mrs. F. Meehan Burns. Malformed egg of common Fowl.

Samuel G. Dixon. Skin of *Scolecophagus carolinus*, from Virginia.

Purchased. Twenty-six bird skins from southern United States; mounted specimens of *Meleagris gallopavo*, Perry Co., Pennsylvania, and *Syrnium occidentale*, Tacoma, Washington.

Reptiles and Batrachians.

Philadelphia Zoological Society. Alcoholic specimens of *Python sebæ, Tupinambis tequixin, Amphiuma tridactyla, Pelophilus madagascarensis, Coronella phocarum;* skull of *Testudo polyphemus* (*?*)

Mexican Expedition 1890. Two jars of lizards from Mexico; eggs of Iguana (*Ctenosaurus cycluroides.*)

Benjamin Sharp, M. D. Alcoholic specimens of *Eutænia sirtalis* and *Heteredon platyrhinus* from Nantucket, Mass.

H. C. Chapman, M. D. Skeleton of Frog, and skulls of a Terrapin and two lizards.

I. C. Martindale. Alcoholic specimen of *Dromicus callilæmus*, from Jamaica.

Benjamin W. Richards. Mounted specimen of *Chelydra serpentina*, from New Jersey.

George Bond. Three jars of snakes and one of lizards.
Witmer Stone. *Clemmys muhlenbergii* (alcoholic), Delaware Co., Pa.
Miss M. E. Lyndall. *Desmognathus fuscus* (alcoholic), Overbrook, Pa.
H. A. Pilsbry. *Clemmys guttatus* (alcoholic), Jamesburg, N. J.
J. T. B. Ives. *Heteredon platyrhinus* (alcoholic), Cape May Point, N. J.
H. Skinner, M. D., and Philip Laurent. *Amblystoma punctatum* (alcoholic), Mitchell Co., North Carolina.
C. R. Johnson. Skin of Red Racer.
U. C. Smith. *Anolis principalis* (alcoholic), Florida.
Purchased. Skin of *Python sebæ*.

FISHES.

Smithsonian Institution. Alcoholic specimens of *Myctophum remiger*, *M. punctatum*, *M. mulleri*, *Stenobrachius coccoi* and *Nannobrachium macdonaldi*.
West Greenland Expedition, 1891. Two jars of fishes from Cape Breton and McCormick Bay.
Mexican Expedition, 1890. *Hippocampus* from Silam, Yucatan.
H. C. Chapman, M. D. Skulls of Cod, Pike and Perch and teeth of three species of fish.
W. J. Fox. *Prionotus palmipes* (alcoholic), from Townsend's Inlet, N. J.
T. D. Harvey and Jos. L. Grauer. Mounted specimen of Marine Sun Fish (*Mola rotunda*), from Anglesea, N. J.
Benjamin Sharp, M. D. Three jars of fishes, Nantucket, Mass.
Thos. A. Walker. *Chilomycterus geometricus* (alcoholic).
Capt. Wm. Wyndham. Skull of *Arius* (*?*) from Surinam.
J. E. Huffington. Rostrum of Saw Fish, from Gulf of Mexico.

CRUSTACEA.

West Greenland Expedition, 1891. Seven jars of Crustacea.
Benj. Sharp, Ph. D. Hermit Crab, from Naples; *Argulus* sp. and five jars of Crustacea, from Nantucket; *Hippa emerita*, *Lepas anserifera*, *Balanus eburneus*, and three jars of other Crustacea, from the New Jersey coast.
Frederick Stearns. *Pycnogonum stearnsi* Ives, types, San Diego, California.
U. C. Smith. *Penæus setiferus* and *Persephone punctata*, Cape Canaveral, Florida.
J. S. Witmer, Jr. *Branchipus vernalis* (alcoholic), Lancaster Co., Pa.
W. J. Fox. *Callinectes hastatus*, *Cymothoa* sp., from Townsend's Inlet, N. J.; 8 jars of Crustacea from Jamaica.
D. N. McCadden. *Platyonicus ocellatus*, Cape May, N. J.
Sister E. Marguerite. *Lepas fascicularis* (alcoholic), Cape May, N. J.
W. Libbey, Jr. *Ocypoda arenaria* (alcoholic), Cape May Point, N. J.
Miss M. A. Schively. *Anoplodactylus lentus*, Woods Holl, Mass.
J. E. Ives. *Limulus polyphemus*, abnormal specimen, Cape May Point, N. J.; two jars of Crustacea from Atlantic City, N. J.

ECHINODERMS, WORMS, CORALS, ETC.

West Greenland Expedition, 1891. Seven jars and four trays of echinoderms, one jar of insects and one of worms, from McCormick Bay, Greenland.

Mexican Expedition, 1890. Twenty-three jars of spiders, scorpions, etc., from Mexico and Yucatan; collection of dried sponges from Yucatan; two trays of corals from Vera Cruz.

Capt. John Powell. *Thyraster serpentarius*, from Vera Cruz.

H. C. Chapman, M. D. *Arbacia punctulata* and *Cliona sulphurea* (alcoholic), *Eschara* and serpuloid tubes, Atlantic City, N. J.

W. J. Fox. Fifteen jars of echinoderms (alcoholic), from Jamaica; worm tubes from Townsend's Inlet, N. J.

Frederick Stearns. Two trays of echinoderms from the Sandwich Islands.

G. S. Lamson. *Anodytes americanus.*

Benj. Sharp, M. D. *Bipalium manubriatum* Sharp, type.

Peary Relief Expedition 1892. Twelve jars of *Antedon eschrichti* from McCormick Bay, Greenland.

C. C. Febiger. *Dactylocalyx subglobosus.*

Miss M. A. Schively. *Amaroecium stellatum*, from Woods Holl, Mass.

Miss M. L. Myrick. *Chalina oculata*, from Nantucket, Mass.

U. C. Smith. Three trays of echinoderms from Cape Canaveral, Florida.

Conchological Section. Five trays of echinoderms and three trays of other marine invertebrates from New Zealand.

Joseph Willcox. Sponge, *Echinaster spinulosum* and *Luidia clathrata*, from Florida.

RECENT MOLLUSCA.

American Association of Conchologists presented through John H. Campbell, President, 443 trays of American shells.

F. L. Billinghurst (in exchange). Thirty-four species of marine shells from Australia.

A. P. Brown. Five species of fresh-water shells from New Jersey.

Dr. H. C. Chapman. *Anomia* and *Columbella* (alcoholic), from Atlantic City.

T. D. A. Cockerell. Four species of marine and fresh water shells from Jamaica and Caymen Island, and types of *Helix vendreyesiana* Ckll.

Conchological Section. Forty species of shells new to the collection.

S. Culin. Two species, *Mitra* and *Ancillaria.*

Geo. W. Dean. *Bourciera heliciniformis* Pfr., from Ecuador.

John Ford. Nine species of shells new to the collection.

Prof. F. W. Hutton. Twelve species of marine shells from New Zealand.

W. W. Jefferis. *Unio* and *Paludina*, from Fort Edward, N. Y.

Chas. W. Johnson. Two species of *Acanthopleura.*

Dr. O. F. von Möllendorff (in exchange). Thirty-five species of land shells from the Philippine Islands; 20 species of *Helix* in alcohol.

Clarence B. Moore. A very large collection of *Vivipara* from the mounds and streams near Lake George, Fla.

H. A. Pilsbry. Twenty-five trays of shells and 10 bottles of alcoholic mollusca; Twenty species of mollusks from Tannersville, Catskill Mountains.

J. B. Quintard. One valve of *Unio quintardii*, the type specimen figured on Pl. VII of this volume.

Geo. D. Ried. *Limnæa palustris* and *Goniobasis virginica* from Deep River, Connecticut.

José N. Rovirosa. Twenty-four species of land and fresh water mollusks from Tabasco, Mexico. (For list see p. 388).

Dr. B. Sharp. Four jaws marine mollusks from Nantucket.

Karl Sharp. *Aporrhais occidentalis*, Nantucket.

U. C. Smith. Three species of *Hydrobiidæ* from Florida.

L. H. Streng. Nine species from Panama; two from the Sandwich Islands.

E. G. Vanatta. Ten species of *Helix*, *Succinia* and *Zonites* from Pennsylvania and New Jersey.

T. W. Vaughan. Fifteen species of fresh-water shells from Louisiana.

G. E. and A. H. Verrill, *Cyclotus amethystinus*, *Helicina velutina* and *Vaginulus punctatissimus*, from Dominica.

Robert Walton. Four species of land shells from Roxborough, Pa.

Joseph Willcox. A large number of recent and fossil mollusks of the United States.

H. W. Winkley. Four trays of mollusks from Maine and Prince Edward Island.

G. W. Wright. Thirty species of marine shells from New Zealand.

Vertebrate Fossils.

Mexican Expedition, 1890. Fragment of tooth of *Elephas primigenius*, Valley of Tequixquiac.

Benjamin Sharp, M. D. Shark's teeth (Miocene), South Carolina; *Diplomystus humilis*, from Green River, Wyoming.

Samuel G. Dixon, M. D. Two molars of *Equus frateruus*; Shark's teeth and four trays of Mammalian remains from Bolton Mines, South Carolina.

J. E. Ives. Patella of *Equus major* from Camden, N. J.

J. P. Lesley. Vertebrate remains from Triassic coal beds of Egypt, North Carolina.

F. M. Naglee. Teeth of *Carcharodon megalodon*, South Carolina.

H. G. Woodman. Slab of Triassic shale, with foot prints and ripple marks, Frenchtown, N. J.

Invertebrate Fossils.

Conchological Section. Nine trays of fossil Helices from Miocene of Germany.

Rev. J. P. Lundy. Twenty-five trays of Cambro-silurian invertebrate fossils from Lake St. John, Quebec, Canada.

Homer Squyer. *Hemiaster humphreysanus*, Cretaceous, Montana.

K. A. Peneeke, M. D. Three trays of fossil land shells, from Steiermark, Germany. Lewis Woolman. Fossiliferous pebbles from Barnegat, N. J.

W. J. Fox. Fossil corals from Jamaica.

H. A. Pilsbry. Twelve trays of Cretaceous fossils, from Farmingdale, N. J.

Joseph Willcox. Sixteen trays of invertebrate fossils.

Saml. G. Dixon, M. D. Fossil corals from Bolton Mines, South Carolina.

Purchased from F. L. Sarmiento. Eighty-nine trays of fossil crinoids and four of other invertebrate fossils, principally from Burlington Co., Iowa; seven trays of cretaceous fossils from Brazil.

PLANTS.

W. G. Warden and Chas. E. Smith. Four hundred and twenty-eight species of phanerogamic plants, sixteen lichens and twenty-six fungi, collected by J. Bornmüller in Pontus and Galatia, Asia Minor, in 1890.

Charles Schaeffer, M. D. Hough's American Woods, Part II., embracing twenty-five species in twenty-six sets of sections, with descriptions, keys, index and title page.

In exchange for duplicate set of Sullivant's Musci Allegheniense:—Two hundred and seventy-five species of plants collected by Dr. Thomas Morong in Central Paraguay in 1888–90.

U. S. Department of Agriculture, Botanical Division. Twenty-four species of Hepaticæ, collected in Georgia and Florida by Prof. L. M. Underwood; thirteen species of Hepaticæ, collected in California by the same; two species of Peronospora, from District of Columbia and Illinois.

Prof. N. L. Britton, Columbia College Herbarium. Seventy-one species of plants collected in British Guiana, by Jenman in 1888.

Prof. José N. Rovirosa. Fifty-one species of plants collected by him in Tabasco and Chiapas, Mexico.

Edwin Faxon, Jamaica Plains, Mass. Series of specimens illustrative of the Sphagna of New England, consisting of seventeen species in twenty-seven forms and varieties, supplementing series received in 1891.

Thomas Meehan. Twenty-one species of plants collected by Mrs. Meehan at Lake Worth, Florida; one hundred and thirty-five species of Australian plants, and two marine Algæ, received from Baron Ferdinand von Müller; seventy-nine species of plants, mostly cultivated and exotic.

J. Bernard Brinton, M. D. Twenty-five species of plants collected on Merritt's Island, E. Florida, by A. A. Baldwin in 1892; eight species mostly from Pennsylvania and New Jersey.

W. W. Jefferis. Ten species of phanerogams and ferns, and thirty-six mosses from the Swiss Alps; twenty species of plants from the Swiss Alps.

Roberts Le Boutillier. *Catasetum viridi-flavum* H, a cultivated orchid, native of Mexico: *Cypripedium bellatulum*, a cultivated orchid, native of Asia.

John H. Redfield. One hundred and sixty-four species of plants collected by Dr. Thomas Morong on the Pilcomayo River, Paraguay, in 1888–90; ten species of North American plants; thirteenth and fourteenth Decades of Underwood's Hepaticæ Americanæ; polished section of the wood of *Cercocarpus ledifolius* (Mountain Mahogany so-called), collected in Utah by the late Dr. C. C. Parry; two hundred and sixty-six species of plants collected by C. G.

Pringle, in the Mexican provinces of Jalisco, San Luis Potosi and Michoacan in 1891.

University of Pennsylvania, through Prof. Joseph T. Rothrock. One hundred and forty-eight species of plants, collected by him in Jamaica and the Bahama Islands in the winter of 1890–1891.

Edward Rand and John H. Redfield. Thirty-one species of plants from Mount Desert, Maine, continuing the series illustrative of the flora of that island.

S. N. Rhoads. Thirty-one species of plants, collected by him in the Santa Catalina Mountains of Arizona, June, 1891.

Thomas Meehan, John H. Redfield and others. Four hundred and sixty-one species of plants collected by P. Sintenis in Asia Minor, Armenia and Kurdistan, in 1888–1890, determined by Stapf and Haussknecht; three hundred and thirty-seven species of plants collected by Sintenis and Bornmüller in Macedonia and Greece in 1891.

West Greenland Expedition 1891, under charge of Prof. Angelo Heilprin. Twenty-seven species of Mosses, collected by Dr. W. A. Burk, and determined by Mrs. N. L. Britton and Messrs. Brotherus and Warnstoff.

Ellis and Everhart. Twenty-eighth Century of North American Fungi, received in exchange for duplicate earlier Centuries, from Estate of Dr. George A. Martin.

Benj. Sharp, M. D. Fruit of Gru-gru Palm (*Aiphanes corallina* Wendl.), from Tobago, W. I.; Spines or excrescences from a tree in the same island.

W. S. W. Ruschenberger, M. D. Photograph of a gigantic Live Oak in Magnolia Cemetery, Charleston, S. C.

Isaac C. Martindale. Abnormal growth of *Polyporus lucidus*, a fungus grown under the floor of an old building at Black River Falls, Wisconsin, collected by Dr. Lucy A. Armadale.

A. C. W. Beecher, M. D. Capsule of a species of *Martynia*, probably *M. lutea*.

Miss Nuttall. Seeds of *Adenopeltis Colliguaya*, inhabited by larva of *Carpocapsa saltatrix*.

Miss Maud G. Waring through Thomas Meehan. Seventy-one species of plants from vicinity of Bloomfield, San Juan Co., New Mexico.

Herbarium of Harvard University. Six hundred and ninety-two species of plants from Estate of the late John Ball, President of the London Alpine Club, collected for the most part in Southern Europe by himself.

Geo. W. Holstein. Ten species of plants collected by him in the Staked Plains of Texas.

Prof. Thos. C. Porter. Eighteen species of plants from vicinity of Easton, Pa.

T. S. Brandegee. Two hundred and sixty-eight species of plants collected by him in the peninsula of Lower California, 1890 to 1892.

Alexander McElwee. *Cytisus scoparius* Link, from near Media, Pa.

Mrs. Mary B. Conard. *Brassavola acaulis* Lindl. (?) a cultivated orchid, native of Panama.

Henry C. Chapman, M. D. Branch of *Citrus trifoliata* L. with ripe fruit, from Zoological Garden, Philadelphia.

FOSSIL PLANTS.

W. W. Jefferis. *Arthrophycus harlani*, Niagara Falls, N. Y.

MINERALS, ROCKS, ETC.

W. W. Jefferis. Two large crystals of Muscovite, Pennsburg, Chester Co., Pa., Hypersthene, Lake George, N. Y.; Iron Pyrites, Falls of French Creek, Pa.; Drusy Quartz, Concord, Delaware Co., Pa.; Diaspore, Chester, Mass.; Quartz, Lewis Co., N. Y.; Siderite in Limonite, Center Co., Pa.; mass of botryoidal Quartz, Yellowstone Park; nineteen trays of other minerals and rocks.

Theodore D Rand. Randite, Frankford, Philadelphia; Native Magnet, Sugartown, Pa,; limestone in serpentine, Copesville, Pa.; Bauxite, Arkansas; sixteen trays of other minerals.

H. G. Ives. Nodule of Pyrite, Germany; Actinolite, Delaware Co., Pa.; Corundum, pseudomorph after Spinel, Franklin, N. J.; Alunogen, Philadelphia.

U. C. Smith. Twelve trays of minerals; Ringing Rock from Schwenksville, Pa.

W. Kennedy. Fulgurites, S. Vineland, N. J.

Joseph Willcox. Phosphorite, Cypress Co., Florida.

Alfred O. Deshong. Three trays of minerals, Leiperville, Del. Co., Pa.

Edwin MacMinn (in exchange). Eleven trays of minerals from Snake Hill, Jersey City, N. J.

S. W. Morton, M. D. Quartz, Rondout, N. Y.; Banded Agate and Smoky Quartz.

Heirs of the late John Warner. Nine bottles of earths.

West Greenland Expedition, 1891. One large meteorite (Tellurite?) and four small specimens from Ovifak, Greenland.

D. N. McCadden. Iron concretion, Cape May, N. J.

Benjamin Sharp, M. D. Fragment of stalactite, from Tobago.

C. S. Welles. Moonstone and limestone, from Media, Pa.

W. W. Potts. Pyrite and Lignite, Montgomery Co., Pa.

W. H. White. Massive Siderite, Montgomery Co., Pa.

H. C. Borden. Chabasite and Bucholzite, from Philadelphia.

H. C. Chapman, M. D. Fragment of boulder from Mt. Desert, and specimen of clay.

Abraham Meyer. Nine trays of rock specimens from Lycoming and Tioga Co., Pa.

A. E. Foote, M. D. Chrysoberyl, from Greenwood, Maine.

John Ford. Bucholzite, Philadelphia.

Joshua Hunt. Calcite, Avondale, Pa.

Lewis Woolman. Concretions in clay, Camden, N. J.

J. D. Winsor. Two weathered rocks, Islesboro, Me.

F. Graff. Stibnite, Japan.

Ignace Domeyko. Nine trays of minerals from Chili, Bolivia and the Argentine Republic.

H. G. Bryant. Labradorite, N. W. River, Labrador.

Mrs. A. M. Thacher. Crystalized Stalactite, Weirs Cave, Virginia; and Quartz Crystals, Middlesex, Herkimer Co., N. Y.

J. E. Richardson. Joesite, from Trondhjem, Norway.

MICROSCOPY, ETC.

Miss Gertrude J. Kenderdine. Microscope and complete outfit; dissecting microscope and 100 slides.

Christian Febiger. Collection of about 10,000 slides of Diatoms, and specimens of diatomaceous earths, made by Col. Christian Febiger.

INDEX TO GENERA, ETC.
1892.

Acanthias 234
Acanthinula 396
Acavus 391
Accipiter 114
Aceratherium 431
Acipenser 241
Acipenseridæ 241
Acris 333
Acrosoma 49
Acusta 393
Adelonycteris 217
Admestina 78
Aegialitis 105, 113, 150
Aegista 214, 393
Aelurodon 425
Aeschrodomus 402
Aëtobatidæ 240
Aëtobatis 240
Agalena 27
Agalenidæ 14, 23
Agaricus 165
Agelaius 108, 120
Agriochoerinæ 434
Agriochœrus 414, 434
Agrœca 23
Ajaja 101
Albacora 256
Alle 146
Allodiscus 402
Allognathus 394, 395
Alopias 233
Alopiidæ 233
Alosa 243, 244
Amaurobius 29
Ambloctonidæ 292
Ambloctonus 292, 312
Amblypoda 439
Amblystoma 332
Ammodramus 109, 112, 152
Ampelita 404
Amphicyon 425
Amphidozotherium 424
Amphilestes 415
Amphioxus 232
Amphispiza 120
Ampullaria 338
Amsonia 162
Amynodon 431
Anacodon 300
Anaptomorphus 212, 418
Anarta 158
Anas 101, 112
Anchippus 326
Anchitherium 326, 411
Ancyloceras 141
Anguilla 244
Anguillidæ 244
Anisonchus 428
Anodonta 339
Anoglypta 400, 403
Anthias 261
Antrostomus 106
Anyphæna 22
Aphelocoma 119
Aphelops 432
Apocynaceæ 162
Apogon 261
Apogonidæ 261
Aquila 114
Aralia 377
Araliaceæ 166
Arconaia 132
Arctictis 426
Arctocyon 292, 420, 421
Arctocyonidæ 292–298, 420
Ardea 102, 113
Arenaria 105
Argiopa 49
Argynnis 157
Argyrodes 31
Argyroepeira 50
Arianta 392
Artiodactyla 433
Arvicola 407
Asclepiadaceæ 162
Aster 384
Astia 78
Atherina 252
Atherinidæ 252
Attidæ 13, 78
Attus 76
Aulonia 73
Aulopus 244
Auriparus 111, 125
Baculites 136–141
Balantiopteryx 217

Balistes 278
Balistidæ 278
Barbarea 169–171
Barbus 242
Bascanium 335
Bassaris 217
Bathmodon 439
Bathyopsis 439
Bathyphantes 44–46
Batrachus 219
Belogona 390, 391
Belone 249
Blenniidæ 275
Blennius 275, 276
Bombus 134, 135
Bombycidae 158
Boops 266
Borophagus 326
Botaurus 102
Bothus 277
Box 266
Branchiostoma 232
Branchiostomatidæ 232
Bubo 116
Buccinum 328
Bufo 332, 337
Bulimulus 218
Buteo 105, 114
Cakile 377
Calcarius 151
Callionymidæ 274
Callionymus 274
Callipepla 114
Calonyction 383
Calymna 402
Camæna 397, 398
Camænella 397, 398
Camœnella 388
Campanula 375, 376
Campylœa 392, 393, 394
Campylorhyncus 124
Canimartes 327
Canistrum 399
Cantharus 265
Capros 258
Caracolina 393
Caracolus 128, 214, 390, 397, 398
Carangidæ 257
Carassius 220, 242
Carcharias 233
Carchariidæ 233
Carcharinus 234
Carcharodon 233
Carcinodon 323
Cardellina 124
Cardinalis 110, 121
Carduus 357–364
Carpodacus 120
Carthamus 357
Carum 161
Cathaica 393
Catharista 105
Cathartes 105, 114
Catherpes 124
Catulus 283
Centaurea 357
Centetidæ 292
Centracanthus 268
Centrina 236
Cephalacanthidæ 273
Cephaloptera 241
Cephalotes 173
Cepola 259
Cepolidæ 259
Cepolis 398
Cepphus 145
Ceratinella 31–33
Ceratinopsis 33
Cercoleptes 217, 426
Cercopithecus 206
Certhia 125
Ceryle 106, 112, 116
Chaetura 107
Charadrius 105
Charax 263
Charopa 401, 402
Charopidæ 401, 402
Chelidon 110, 122, 152
Chelydra 333
Chilotrema 392
Chimæra 241
Chimæridae 241
Chloritis 393, 397, 398, 399
Chlorœa 393
Chondestes 109, 120
Chondropoma 338
Chordeiles 107, 116
Chorophilus 333, 337
Chriacus 295, 415
Chromis 271, 333, 337
Chrysochloridídæ 292
Chrysodomus 328
Chrysophrys 263
Cicurina 26
Cistudo 333
Clænodon 298, 420, 421
Clivicola 110, 122
Clubiona 20–22
Clupea 243, 244
Clupeidæ 242
Cnemidophorus 334, 337
Cnicus 357
Coccyzus 106
Cochlostyla 395
Cœlotes 24–26
Colaptes 116

Colias..... 156
Colinus..... 105
Columba..... 112, 114
Columbigallina..... 112, 114
Conger..... 246
Congridæ..... 246
Coniferæ..... 164
Conoryctes..... 323
Contia..... 335, 337
Contopus..... 108, 118
Corasia..... 393
Coriarachne..... 57
Cornicularia..... 34
Cornus..... 376, 377
Corvus..... 119, 152
Coryda..... 393, 395
Coryphæna..... 253
Coryphænidæ..... 253
Coryphodon..... 439
Craspedaria..... 393
Crecoides..... 226
Crenilabrus..... 270, 271
Cristiceps..... 276
Cristigibba..... 399
Crotalophorus..... 336, 337
Crotalus..... 336, 337
Croapshytus..... 335, 337
Crotophaga..... 106
Cryptus..... 134
Ctenolabrus..... 271
Cuscuta..... 383
Cyanocitta..... 119
Cybæus..... 23
Cyclophorus..... 338
Cyclopidius..... 435
Cyclosa..... 49
Cyclotus..... 338
Cylindrella..... 338
Cynocephalus..... 212
Cynohyænodon..... 292
Cyprinidæ..... 242
Cyprinus..... 242
Cyrtonyx..... 114
Cysticopsis..... 214, 397
Cystophora..... 424
Dactylopterus..... 273
Dædalochila..... 400
Dalibarda..... 371, 372
Dasyatidæ..... 240
Dasyatis..... 240
Dasychira..... 158
Dasyurus..... 412
Decapterus..... 257
Deltatherium, 292, 308, 418, 419, 421, 422
Dendrocygna..... 112
Dendroica..... 111, 123, 152
Dendryphantes..... 74, 75
Dentellaria..... 215, 390, 393, 398
Dentellocaracolus..... 373
Dentex..... 263, 267
Desmatotherium..... 431
Diachæa..... 329
Diacodon..... 292
Diaglyptus..... 402
Dialeuca..... 395
Dicentrarchus..... 259
Dichobune..... 437
Dichodon..... 438
Dicotyles..... 414, 438
Dictyna..... 27–29
Didelphodus..... 292, 311
Didymictis..... 292, 318, 419, 422, 425
Dinictis..... 425
Diplacodon..... 432
Diplodus..... 261–263
Diplostyla..... 43
Dipœna..... 31
Dissacus..... 303, 418, 420
Dolerus..... 133
Dolomedes..... 73
Dorcasia..... 393
Drassidæ..... 14
Drapetisca..... 44
Drassus..... 19
Drexelia..... 127, 128
Dromatherium..... 405
Dryobates..... 106, 116
Dysderidæ..... 13
Echelidæ..... 247
Echelus..... 247
Echeneis..... 253
Echineididæ..... 253
Ellipsodon..... 298
Elona..... 392
Embernagra..... 109
Empidonax..... 119, 152
Endodonta..... 400, 401, 402
Engraulis..... 244
Entelurus..... 250
Epeira..... 49, 127
Epeiridæ..... 14, 49
Epiblemum..... 78
Epichriacus..... 296, 421
Epinephelus..... 260
Epiphallophora..... 391, 397
Epiphragmophora..... 394
Equus..... 226, 227, 228
Eremina..... 392
Ereunectes..... 104
Ericaceae..... 372
Erigone..... 41
Eris..... 77
Ero..... 30
Erynguim..... 166
Eschatius..... 436

Escholtzia..... 454
Esocidæ..... 249
Esox..... 249
Eucalodium..... 338
Eucitharus..... 277
Eugenes..... 117
Euhadra..... 393
Eulota.....392, 393
Eumeces..... 334
Euparypha..... 392
Euphrasia..... 366
Eupleres..... 426
Eurycampta..... 394
Eurycratera..... 393
Eurycrateria..... 398
Euryopsis..... 31
Eutænia 336, 337
Exocœtidæ..... 249
Exocœtus..... 249
Exolytus..... 134
Falco.....105, 114, 150
Felis..... 217
Flesus..... 277
Fragaria..... 371
Fruticicola..... 392
Fulica..... 113
Fulmarus..... 149
Gadidæ..... 276
Gadus..... 276
Galecynus..... 425
Galeus..... 234
Gallorhinidæ..... 234
Gallinula..... 113
Gaura..... 367
Gavia..... 148
Gaylussacia..... 374
Gelochelidon..... 101
Gelocus..... 437
Geococcyx.....106, 116
Geothlypis.....111, 124
Geotrochus..... 393
Gerontia.....401, 402
Glandina..... 338
Glaucopteryx..... 159
Glypterpes..... 394
Glyptostoma..... 396
Gnaphosa..... 19
Gobiidæ..... 274
Gobius.....274, 275
Goniacodon.....301, 421
Gonostoma.....393, 394
Gorilla.....203–212
Grammonota..... 34
Guira..... 121
Gymnosarda.....254, 256
Gymnothorax..... 248
Gymnura..... 424
Habia..... 121
Habrocestum.....77, 78
Hadra.....397, 399
Hahnia..... 27
Haplocomus..... 428
Haplogona.....391, 400
Harporhynchus..... 111
Harengula.....242, 243
Harporhyncus..... 124
Harpyia..... 173
Hasarius..... 77
Hecla..... 156
Helaletes.....414, 431
Helicina..... 339
Helicodiscus..... 402
Helicophanta..... 391
Helix.....129, 388, 392–395
Helminthophila..... 123
Helophora..... 44
Hemicycla.....392, 393
Hemicyon..... 425
Hemiganus..... 323
Hemipsalodon..... 316
Hemithlæus..... 428
Hemitrochus.....129, 214, 395
Heptodon..... 431
Heptranchias..... 234
Herpestis..... 217
Heteroborus..... 292
Heterodon.....333, 336, 337
Hexanchidæ..... 234
Himantopus..... 104
Hippa..... 327
Hippocampus..... 249
Hippotherium..... 325
Holbrookia.....335, 337
Holomeniscus..... 436
Homalattus..... 80
Hyæna..... 326
Heyænarctos..... 425
Hyaenodon.....292, 317, 419, 422
Hyaenodontidæ.....292–313, 419, 422
Hyalosagda..... 213
Hydrochelidon..... 101
Hyodectes..... 292
Hyohippus..... 326
Hyopsodus..... 418
Hypecoum..... 454
Hypericum..... 378
Hypisodus..... 437
Hypochilidæ..... 13
Hypochilus..... 13
Hypoptychus..... 395
Hyptiotes..... 52
Hyrachyus.....431, 432
Hyracodontidæ..... 430
Hyracoidea..... 429
Hyracotherium.....411, 441
Hyrax..... 429

Iberus..... 392
Ichneumon..... 134
Icius..... .76, 77
Icteria.....111, 124
Icterus.....109, 120
Ictops.....292, 422
Ilex..... 167
Ipomœa..... 383
Isectolophus..... 430
Isognomostoma..... 392
Isomeria.....215, 398
Isurus..... 233
Jeanneretia..... 395
Julis..... 271
Junco..... 120
Kinosternum.....333, 337
Labridæ..... 269
Labrus.....269, 270
Labyrinthus.....215, 398
Lacertilia..... 334
Lagopus..... 150
Lambdotherium.....432, 433
Lamna..... 233
Lamnidæ..... 233
Lanius.....110, 122
Laoma..... 413
Laria..... 158
Larus.....101, 149
Lathyrus..... 379
Lepidopus..... 254
Lepidotrigla..... 274
Leptictidæ.....292, 422
Leptictis..... 423
Leptocephalus..... 246
Leptomeryx..... 436
Leptotragulus..... 435
Leptauchenia..... 435
Leptaxis.....392, 393
Lepus..... 251
Leuciscus..... 242
Leucochroa..... 394
Libera..... 402
Lichia.....257, 258
Limnotherinm..... 212
Linyphia.....41, 42
Liochila..... 398
Listriodon..... 438
Lonicera.....379–381
Lophiidæ..... 278
Lophiomeryx..... 434
Lophius.....231, 278
Lophocarenum.....35–38
Lophomma..... 35
Lota..... 277
Loxolophus..... 297
Lucerna.....129, 215,
Lupinus.....364,
Luzula.....
Lycæna..... 157
Lycosa.....64, 68
Lycosidæ.....13, 64
Lysimachia..... 374
Lysinoe..... 394
Macacus..... 206
Macrocyclis..... 404
Macroon.....390, 391
Macroscelidæ..... 423
Macularia.....392, 393
Mæna..... 267
Malva..... 452
Mantidæ..... 241
Maoriana..... 402
Marptusa..... 79
Mastodon.....227, 228, 489
Megalonyx.....227, 228
Magascops.....106, 116
Melanerpes.....106, 116
Melanta..... 154
Meleagris.....105, 114
Meles..... 426
Meletta..... 243
Melopelia..... 126
Melospiza.....109, 121, 152
Meniscotherium..... 429
Merychippus..... 326
Merycochœrus..... 435
Merychyus.....435, 441
Merlangus..... 276
Merluccius..... 277
Merula.....126, 152
Mesodectes.....292, 423
Mesodon.....393, 400
Mesonychidæ, 292–303, 419, 421, 424
Mesonyx.....292, 303, 420, 421
Mesotapirus..... 430
Meta.....12, 49, 127
Metodontia..... 393
Miacidæ.....292–294. 318, 419. 425
Miacis.....292, 320
Micaria..... 14
Microclænodon..... 302
Microneta.....46–48
Micropallus..... 116
Microphysa..... 213
Micropus..... 117
Milvulus..... 107
Mimetus..... 30
Mimus.....111, 124
Mioclænus.....292–295, 321, 413, 422
Misumena..... 57
Mixodectes..... 417
Mobula..... 241
Mola..... 278
..... 278
.....108, 119
..... 277

Monarda.....449–454
Moneses.....374
Monochirus.....277
Monotropa.....373
Mora.....277
Mugil.....250
Mugilidæ.....250–252
Mullidæ.....268
Mullus.....268
Muræna.....247
Muræenidæ.....247
Mustelidæ.....426
Mustelus.....234
Mycteroperca.....260
Mygalidæ.....13
Myiarchus.....107, 118
Myliobatis.....240
Mythomyidæ.....292
Nanohyus.....441
Natrix.....336, 337
Naucrates.....257
Necrolemur.....212
Nematus.....133
Neon.....80
Neophanes.....29
Nephila.....127
Nimravidæ.....425
Noctuidæ.....158
Noctulinia.....217
Notharctus.....212
Numenius.....104
Nycticorax.....104
Nyctidromus.....106
Nymphalidæ.....157
Nymphaea.....368
Obba.....393, 397, 398
Oblada.....266
Ochthephila.....393
Ocyale.....73
Œnothera.....368
Onychodectes.....323
Ophibolus.....335, 337
Ophidia.....335
Ophidion.....276
Ophiidae.....276
Ophiocten.....350
Ophisoma.....246
Ophisuridæ.....247
Ophisurus.....247
Oreodon.....435, 441
Oreodontidæ, 433, 434, 438, 441–443
Ornithogalum.....169
Orthagoriscus.....278
Ostracion.....278
Ostrea.....350, 352
Otariidae.....424
Otocoris.....108, 119
Oxalis.....288
Oxyæna.....292, 314, 418, 419, 422
Oxyænidæ.....292
Oxyclænidæ.....294
Oxyclænus.....295
Oxychona.....395
Oxyclœnus.....419
Oxynotus.....236
Oxyptila.....57
Oxyrhina.....233
Pachyæna.....304, 420
Pachychilus.....153, 339
Pachygnatha.....51
Pagellus.....263
Pagrus.....263
Palæomeryx.....437, 438
Palaeoniciidæ.....294
Palæonictis.....292, 311, 418, 419, 422
Palæosyops.....432, 433
Palæotheriidæ.....430
Pandion.....106
Pantolambda.....439
Pantolestes.....292, 433, 437
Papuina.....397, 399
Parabuteo.....105
Paracentropristis.....260
Paradoxodon.....322
Parahippus.....326
Paralepididæ.....244
Paralepsis.....244
Parasilurus.....241
Parasorex.....423
Pardosa.....68–71
Parthena.....398
Parus.....111, 125
Passarina.....121
Passerina.....110
Patriofelis.....292, 313
Patula.....400, 401, 402
Pedinogyra.....404
Pelamys.....256
Pelycodus.....295, 415
Pentacodon.....296
Perca.....268
Perchœrus.....438
Percidæ.....268
Periptychidæ.....420, 428, 429
Periptychus.....428
Peristedion.....273
Peristethion.....273
Petasia.....393
Petrochelidon.....110
Petromyzon.....232
Petromyzontidæ.....232
Peucaea.....109, 121
Phacussa.....402, 403
Phainopepla.....122
Phalacrocorax.....101

Phalænoptilus..... 116
Phalaropus..... 150
Phania..... 391
Phenacodontidæ..... 427, 430
Phenacodus..... 413, 427
Phenacohelicidæ..... 401, 402
Phenacohelix..... 402
Phidippus..... 73
Philæus..... 74
Philodromus..... 59–64
Phocidae..... 424
Pholcomma..... 31
Phrixgnathus..... 403
Phrurolithus..... 22
Phrynosoma..... 335, 337
Phycis..... 276
Phyllostomidæ..... 173
Pieridæ..... 156
Pieris..... 381
Pinicola..... 152
Pipilo..... 121
Piranga..... 110, 122
Pirata..... 71
Pithecistes..... 435
Pityophis..... 335, 337
Pitys..... 401
Plagioptycha..... 129, 395, 396
Planispira..... 397, 399
Platophrys..... 277
Plebecula..... 392
Plectotropis..... 393
Plectrophenax..... 151
Plesiarctomys..... 426
Pleuronectes..... 277
Pleuronectidæ..... 277
Pliauchenia..... 228
Plusia..... 158
Pœcilochroa..... 19
Poebrotherium..... 435, 436
Polioptila..... 112, 125
Pollachius..... 276
Polyborus..... 105, 114
Polydontes..... 398
Polygonum..... 163, 384
Polygyra..... 128, 400
Polygyratia..... 404
Polygyrella..... 400
Polymita..... 395
Polyplacognatha..... 391, 403
Polyporus..... 165
Polyprion..... 261
Pomacentridæ..... 271
Pomatia..... 392
Pomatomidæ..... 258
Pomatomus..... 258
Potamanax..... 340
Potamogalidæ..... 292
Praticolella..... 400
Procamelus..... 414, 436, 438, 440, 443
Procavia..... 429
Procyon..... 217, 426
Procyonidæ..... 426
Prodremotherium..... 437
Proboscidea..... 439
Progne..... 110, 122
Prosthesima..... 17–19
Prothelidomus..... 393
Protochriacus..... 296
Protogonodon..... 322, 427
Protogonia..... 413, 415, 427
Protohippus..... 325
Protopsalis..... 293, 316
Protoreodon..... 433
Proviverra..... 292, 311, 419
Proviverridae..... 292–294, 307
Psaltriparus..... 125
Psetta..... 277
Pseudogryphus..... 114
Pterodon..... 292, 422
Pteropus..... 172
Punctum..... 403
Pycnogonum..... 142
Pyrocephalus..... 108, 119
Pyrochilus..... 391
Pyrola..... 374
Pyrrha..... 402
Pyrrhuloxia..... 110, 121
Quercytherium..... 292, 422
Quiscalus..... 109
Raja..... 237–240
Rajidæ..... 237
Rallus..... 104
Rana..... 333
Ranunculus..... 168
Raphanus..... 381
Recurvirostra..... 104
Regulus..... 125
Remora..... 253
Rhagatherium..... 437
Rhinobatidae..... 236
Rhinobatus..... 236
Rhinoceros..... 432
Rhombus..... 277
Rhus..... 368–371
Rhynchonycteris..... 217
Rhynchops..... 101
Ri-sa..... 149
Rubus..... 371, 384
Runcinia..... 59
Sagda..... 213–215, 396
Saitis..... 78
Salientia..... 332
Salmo..... 244
Salmonidæ..... 244
Salpinctes..... 124
Sarcothraustes..... 302, 421

Sarda 256
Sardinella 242
Sargus 261–263
Satsuma 393
Saurus 244
Saxicola 152
Sayornis 118
Scaphites 140
Scatharus 265
Sceloporus 336
Sciæna 269
Sciænidæ 269
Sciurus 111
Scomber 254
Scombresox 249
Scombridæ 254
Scorpæna 274
Scorpænidæ 274
Scylliorhinidæ 233
Scylliorhinus 233
Scyllium 233
Serranidæ 259
Serranus 259, 260
Setophaga 124, 152
Sialia 126
Siluridæ 241
Silurus 241
Simplicaria 402
Singa 49
Sinopa 308, 419, 420, 422
Siphonostoma 250
Sitta 125
Smaris 267
Solaropsis 404
Solea 277, 278
Somateria 149
Sparidæ 261
Sparus 263, 264
Spatula 101
Spea 333, 337
Speotyto 112
Sphyræna 253
Sphyrænidæ 253
Sphyrna 234
Sphyrnidæ 234
Spicara 267, 268
Spinus 120
Spirifer 350
Spiropalpus 84
Spondyliosoma 265
Squalidæ 234
Squalus 234
Squatina 236
Squatinidæ 236
Steatoda 31
Stelgidopteryx 110, 122
Stellaria 166
Stemonyphantes 43
Stenotrema 400
Stercorarius 146
Sterna 101
Stolephoridæ 244
Stolephorus 244
Stomateidæ 258
Stomateus 258
Streptostyla 338
Strix 112
Strobila 403
Strobilops 403
Sturnella 108
Stylodonta 391, 395
Stypolophus 292, 419
Suteria 402
Symphemia 104
Symphodus 270, 271
Synageles 80
Synemosyna 80
Syngnathidæ 249
Syngnathus 250
Synodontidæ 244
Synodus 244
Syrnium 106, 115
Systemadon 430
Tachea 392, 393
Tachycineta 122
Talpidæ 292, 424
Taxidea 217, 426
Tectula 393
Tegenaria 26
Telmatherium 432
Testudinata 333
Testudo 226
Tetrabelodon 226, 227
Tetraclænodon 299, 421, 422
Tetragnatha 51
Thalassia 402
Thalassohelix 402
Thalossoma 271
Thargalia 15–17
Theleophalla 390, 396
Thelidomus 215, 393, 398
Theridiidæ 14, 30
Theridium 30
Therasia 402, 403
Thinocyon 321
Thinohyus 438
Thomisidæ 14, 52
Thryothorus 111, 124
Thynnus 254, 256
Tibellus 59
Tinca 242
Titanœca 29
Titanotheriidæ 430
Titanotherium 432, 433
Tmarsus 59
Tmeticus 38–41

Torpedinidæ..... 236
Torpedo..... 236
Totanus..... 104
Trachela..... 22
Trachinidæ..... 272
Trachinus..... 272
Trachurus..... 257
Trachypterus..... 259
Trachypteridæ..... 259
Tragulus..... 436
Tricentes..... 297
Trichiuridæ..... 254
Trichiurus..... 254
Triconodon.....412, 415
Trifolium..... 378
Trigla..... 273
Triglidæ..... 273
Triisodon.....292, 300, 421
Triisodontidæ.....294, 300, 421
Tringa..... 104
Tringo..... 150
Trionyx.....334, 337
Triodopsis.....393, 400
Tripterygion..... 276
Trochilus.....107, 117, 118
Trochomorpha.....400, 402
Troglodytes..... 125
Trutta..... 244
Trygon..... 240
Tupaiidæ..... 423
Turdus..... 125
Tursiops..... 289
Tyrannus.....107, 118
Typhle..... 250
Uloborus..... 52
Umbrina..... 269
Unio.....131, 339
Uranoscopidæ..... 272
Uranoscopus..... 272
Uria.....146, 152
Urodela..... 332
Urosalpinx..... 328
Ursus..... 425
Valerianaceæ..... 166
Vallonia.....393, 396
Vampyrus..... 217
Vinca..... 162
Vireo.....111, 122
Viverravus..... 321
Viverridae..... 425
Xerophila..... 392
Xiphias..... 253
Xiphiidæ..... 253
Xiphodontherium..... 437
Xyrichthys..... 271
Xysticus.....52–57
Yoldia..... 350
Zenaidura.....105, 126
Zenidæ..... 258
Zeus..... 258
Zonites..... 394
Zonitidæ..... 389
Zoogenites..... 402
Zygæna..... 234
Zygoballus..... 80

GENERAL INDEX.
1892.

Additions to the Museum.

Allen, Harrison, M. D. On the Molars of Pteropine Bats, 172. On the cephalo-humeral muscle and the so-called rudimental clavicle of Carnivora, 217. On the foramen magnum of the common Porpoise, and on a human lower jaw of unusual size. 289.

Banks, Nathan. The spider fauna of the Upper Cayuga Lake Basin, 11.

Bates, Henry Walter, announcement of death of, 129.

Biological and Microscopical Section, report of, 494.

Botanical Section, report of, 498.

Brown, Amos P. The development of the Shell in the coiled stage of Baculites compressus Say, 127, 136.

Bryant, Henry G. Address on the Grand Falls of Labrador (no abstrac 10.

Chapman, Henry C., M. D. Observations on the brain of the Gorilla, 10, 203. Note on the geology of Mt. Desert Island, 350.

Conchological Section, report of the, 495.

Cope, Edw. D. A contribution to a knowledge of the fauna of the Blanco Beds of Texas, 225, 226. The Batrachia and Reptilia of Northwestern Texas, 324, 331. On a collection of Batrachia and Reptilia from Washington and British Columbia, 324. On the permanent and temporary dentitions of certain Three-toed Horses, 325. A Hyæna and other Carnivora from Texas, 326.

Corresponding Secretary, report of, 488.

Cummins D. B., announcement of death of, 216.

Curators, report of, 491.

Dohrn, C. A., announcement of death of, 216.

Dougherty, Wm. H., announcement of death of, 153.

Elections during 1892, 508.

Entomological Section, report of 497.

Foote, A. E., M. D. A meteoric stone seen to fall at Bath, South Dakota, 353.

Formad, Henry F., M. D., announcement of death of, 225.

Fox, Wm. J. Report on the Hymenoptera collected in West Greenland, 10, 133.

General Index, 528.

Greene, Edward L. Eclogæ Botanicæ, No. 1, 357.

Hayden Memorial Geological Award, report of Committee, 354.

Heilprin, Angelo. Appointment as Leader of Peary Relief Expedition, 10. Report of Peary Relief Expedition, 290. Report of Professor of Invertebrate Paleontology, 500.

Hockley, Thomas, announcement of death of, 154.

Hoffman, Horace Addison and David Starr Jordan. A catalogue of the Fishes of Greece, with notes on the vernacular names now in use and those employed by classical authors, 218, 230.

Index to Genera, 519.

Ives, J. E. A new species of Pycnogonum from California, 128, 142.

Jefferis, Wm. W. Report of the Curator of the William S. Vaux Collections. 502.

Jessup Fund, report on, 504.

Keller, Ida A. The phenomenon of fertilization in the flowers of Monarda fistulosa, 452.

Knight, Edw. C., announcement of death of, 287.

Librarian, report of, 489.

McCook, Rev. H. C., D. D. Drexelia, a new genus of spiders, 127.

Meehan, Thomas. Contributions to the life-histories of plants, No. 7: On the vitality of some annual plants; On self-pollination in Amsonia tabernæmontana; On a special form of cleistogamy in Polygonum acre; On the direction and growth in cryptogamic plants; Tricarpellary Umbelli-

fers; A mode of variation in Stellaria media; On the sexes of the Holly; On the stamens of Ranunculus abortivus; On the character of the stamens in Ornithogalum umbellatum; Note on Barbarea in connection with dichogamy, 160. Contributions to the life-histories of plants, No. 8: Euphrasia officinalis; Notes on Gaura and Œnothera; The carpellary structure of Nymphæa; On the sexual characters of Rhus; Rhus chamæmorus; Dalibarda repens; On some morphological distinctions in the genera of Ericaceæ; Vitality of Seeds, Lysimachia atropurpurea; Campanula rotundifolia; Cornus Canadensis; Aralia hispida; Luzula campestris; Cakile Americana; Hypericum ellipticum; Trifolium hybridium; Lathyrus maritimus; Lonicera cœrulea; Raphanus sativus, On the nature and verrucæ in some Convolvulaceæ; Polygonum cilinode; Aster tatarica, 350, 366. Notes on Monarda fistulosa, 449. Report of Botanical Section, 498.

Miller, Andrew H., announcement of death of, 127.

Mineralogical and Geological Section, report of, 500.

Nassau, Rev. R. H. Notes on the Gorilla (no abstract), 10.

Nolan, Edw. J., M. D. Report of Recording Secretary, 485. Report of Librarian, 489.

Officers, Councillors and Finance Committee for 1893, 508.

Ornithological Section, report of, 503.

Parker, Andrew J., M. D., announcement of death of, 154.

Peary, R. E. Greenland Explorations, 290. Report of the operations of the North Greenland Expedition of 1891-1892, 342.

Peary Relief Expedition, authorization of, 10.

Pilsbry, H. A. Anatomy of West Indian Helices, 128. New and unfigured Unionidæ, 131. A new species of Pachychilus, 153. On the anatomy of Sagda, Cysticopis, Ægista and Dentellaria, 155, 213. Notes on a collection of shells from the State of Tobasco, Mexico, 324, 338. A new Marine Gasteropod from New Jersey, 328. Preliminary outline of a new classification of the Helices, 387. Report of the Conchological Section, 495.

Professor of Invertebrate Paleontology, report of, 500.

Professor of Lower Invertebrata, report of, 501.

Rand, Theodore D. Geology of the Isle of Shoals, 324. The supposed South Chester Valley Hill Fault, 445.

Rand, Theodore D., William W. Jefferis and J. T. M. Cardeza, M. D. Mineral localities of Philadelphia and vicinity, 174. Report of Mineralogical and Geological Section, 500.

Recording Secretary, report of, 485.

Redfield, John H. Report of Botanical Section, 498.

Rex, Geo. A., M. D. Diachœa Thomasii, a new species of Myxomycetes, 329.

Report of the Biological and Microscopical Section, 494.

Report of Botanical Section, 498.

Report of the Conchological Section, 495.

Report of Corresponding Secretary, 488.

Report of the Curator of the Wm. S. Vaux Collections, 502.

Report of Curators, 491.

Report of the Entomological Section, 497.

Report of the Librarian, 489.

Report of the Mineralogical and Geological Section, 500.

Report of the Ornithological Section, 503.

Report of Professor of Invertebrate Paleontology, 500.

Report of Professor of Lower Invertebrata, 501.

Report of Recording Secretary, 485.

Report on the Jessup Fund,

Rhoads, Samuel N. The birds of Southeastern Texas and Southern Arizona observed during May, June and July, 1891, 98. The Birds of British Columbia and Washington observed during the spring and summer of 1892, 448.

Ruschenberger, W. S. W., M. D. Report of Curators, 491. Report on the Jessup Fund, 504.

Ryder, John A. On the mechanical genesis of the scales of fishes, 172, 219. Diffuse pigmentation of the epidermis of the oyster due to prolonged exposure to the light: regeneration of shell and loss of adductor

muscle, 350. The hermaphroditism and viviparity of the oysters of the northwest coast of the United States, 351. On the cause of the greening of the oyster and its presumed algous endoparasites, 352. The principle of the conservation of energy in biological evolution: a reclamation and critique, 447, 455.

Scott, Wm. B. A review of the North American Creodonta with notes on some genera which have been referred to that Group, 290, 291. The evolution of the premolar teeth in the Mammals, 405.

Sharp, Benjamin, M. D. On the Hippa emerita, 327. Report of Corresponding Secretary, 488. Report of Professor of Lower Invertebrata, 501.

Skinner, Henry, M. D. Report of Entomological Section, 497.

Skinner, Henry, M. D. and Levi W. Mengel. Greenland Lepidoptera, 154, 156.

Standing Committee for 1892, 9.

Stone, Witmer. Birds collected by the West Greenland Expedition, 128, 145. Report of the Ornithological Section, 503.

Tryon, Edw. K., announcement of death of, 9.

Walker, Ernest. The autosporadic seeds of Oxalis stricta, 287, 288.

Watson, Sereno, announcement of death of, and resolutions, 154.

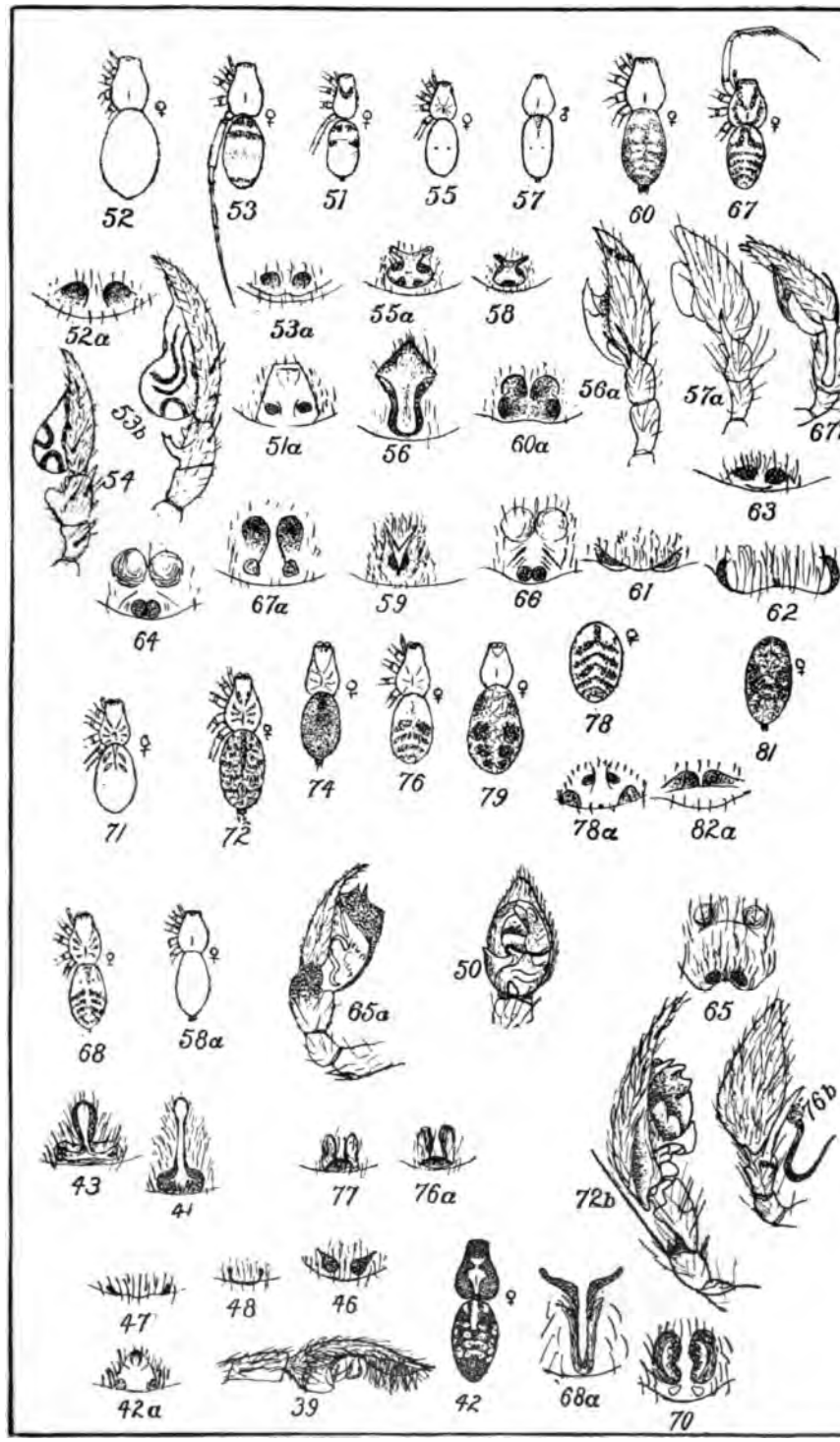
Willcox, Jos. A theory of the origin and development of the earth and heavenly bodies (no abstract), 448.

Wingate, Harold. Report of Biological and Microscopical Section, 494.

Wistar, Isaac J. Remarks on the quantity, rate of consumption and probable duration of North American coal and the consequences to air-breathing animals of its entire consumption, 10, 82.

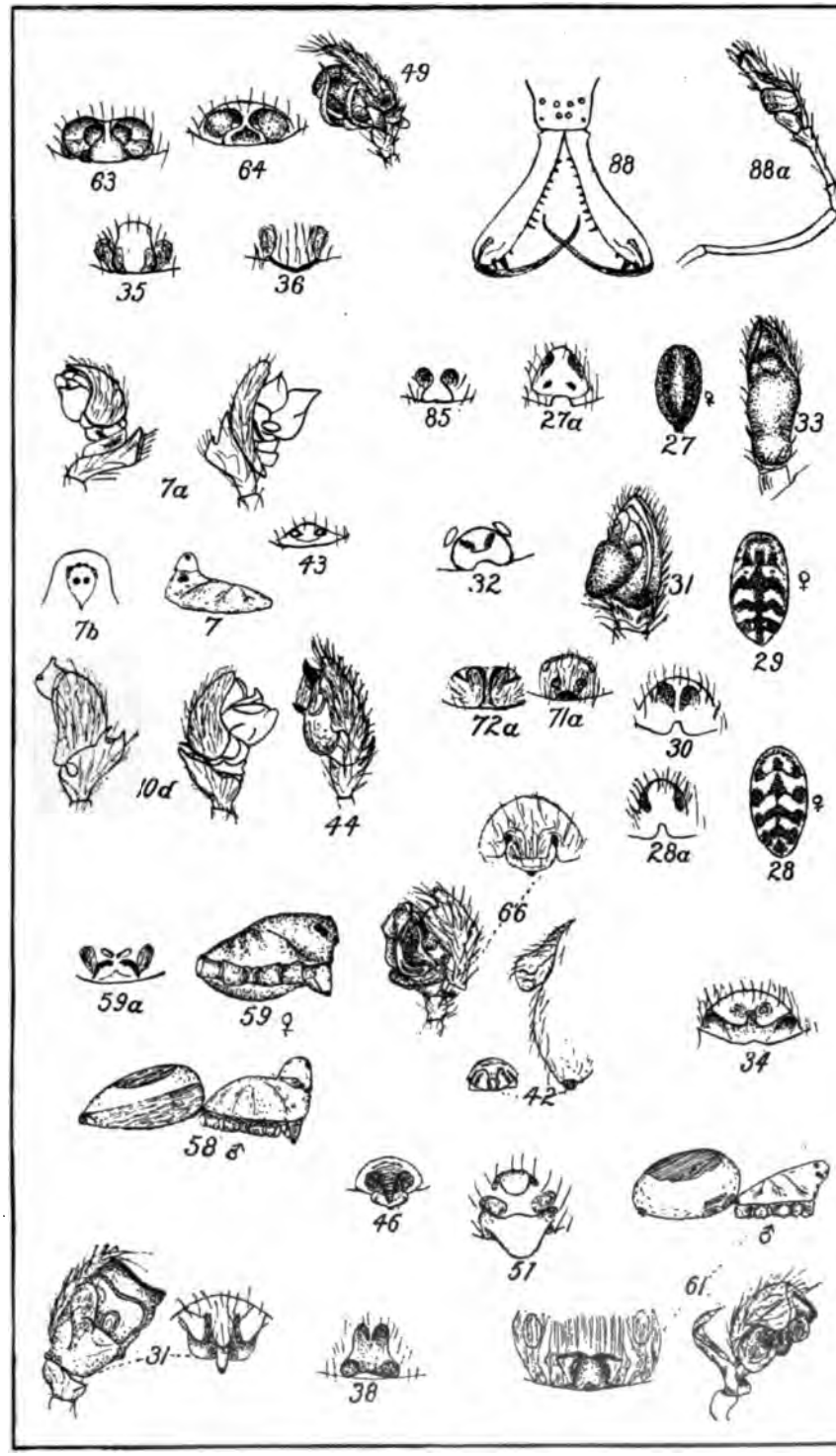
Wm. J. Vaux Collections, report of Curator of, 502.

Wright, G. Frederick. Extra Morainic drift of the Susquehanna, Lehigh and Delaware Valleys, 448, 469. Evidences of the existence of paleolithic man in America (no abstract), 448.



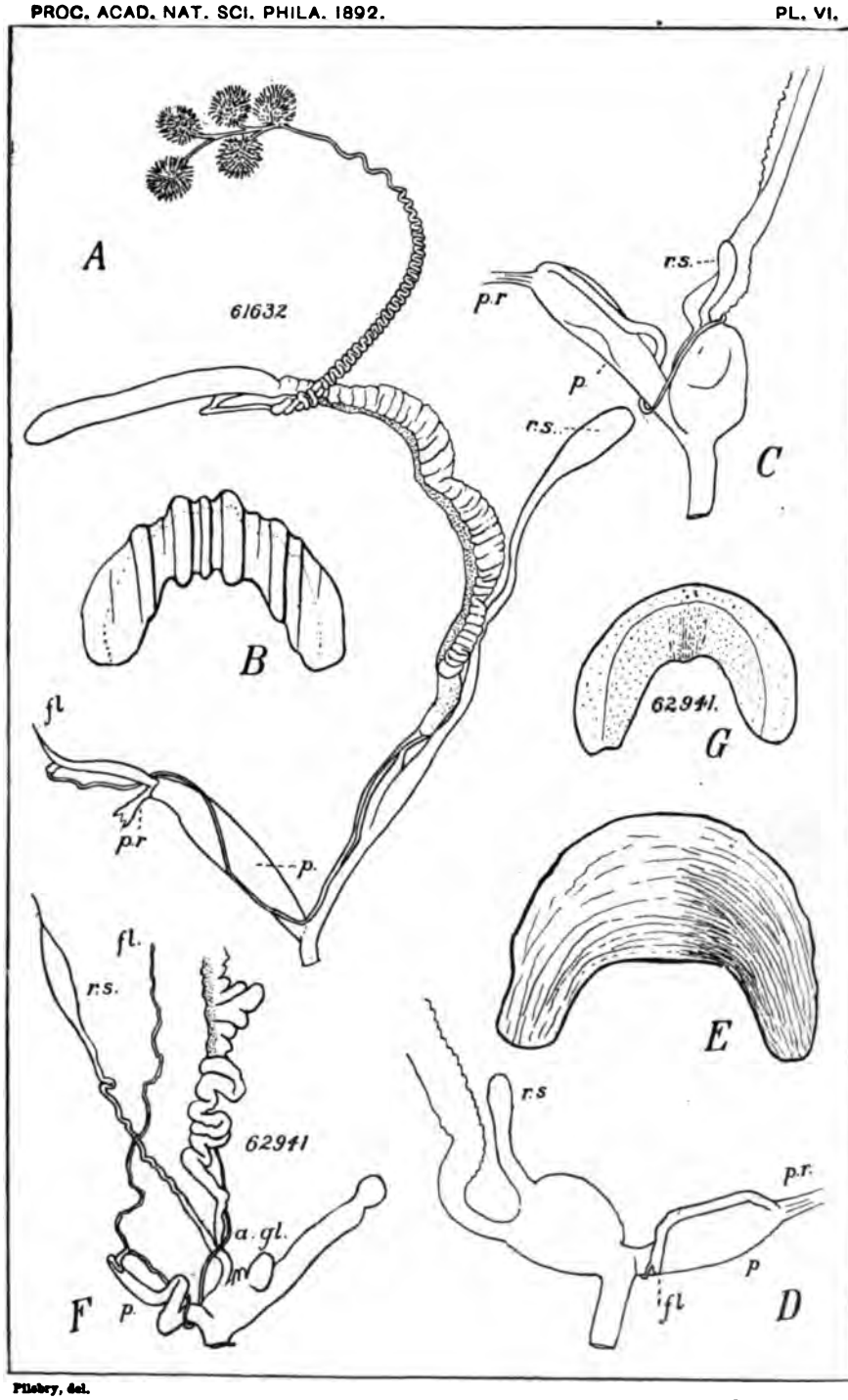
Banks, del.

BANKS, SPIDERS OF UPPER CAYUGA BASIN.



Banks, del.

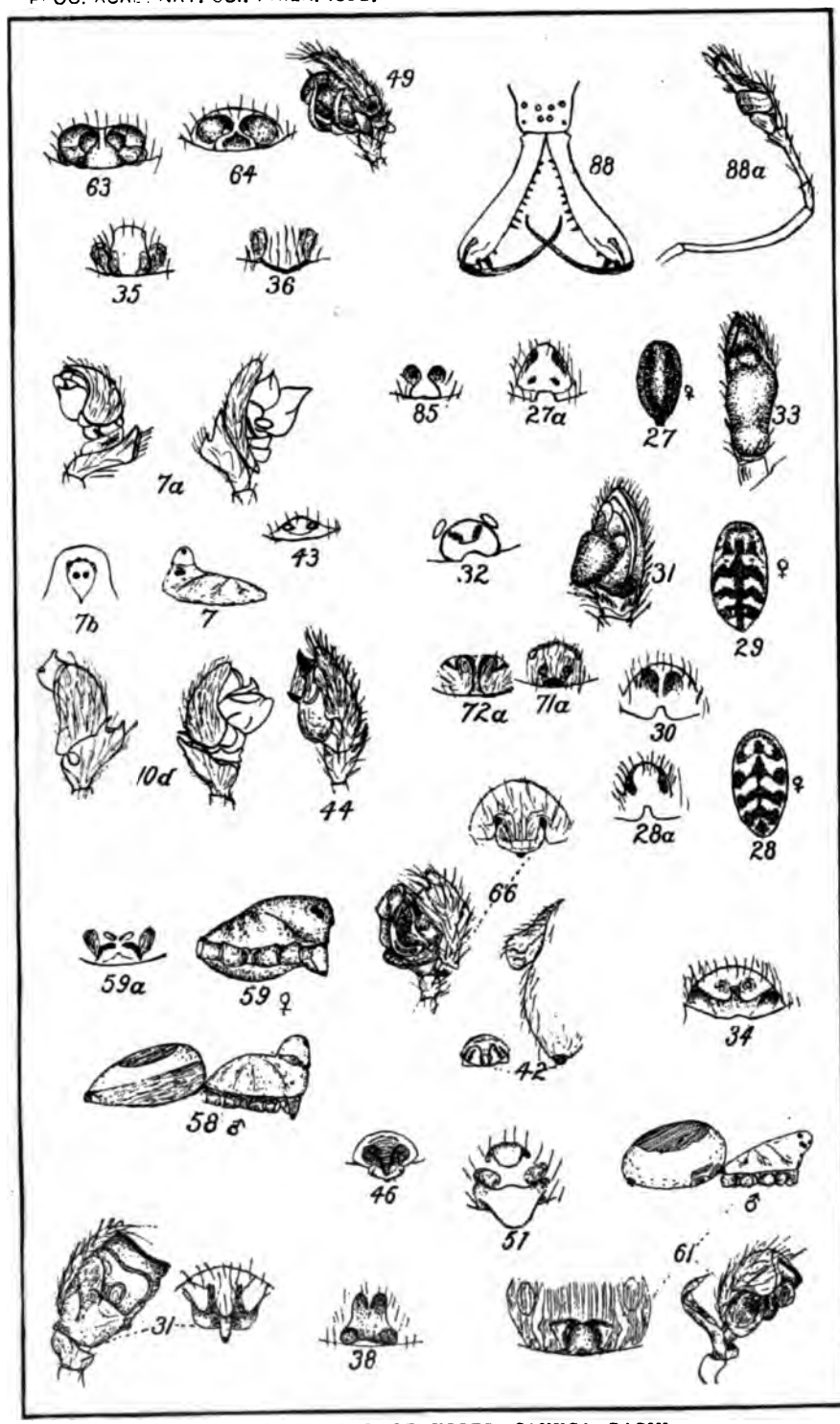
BANKS, SPIDERS OF UPPER CAYUGA BASIN.



Pilsbry, del.

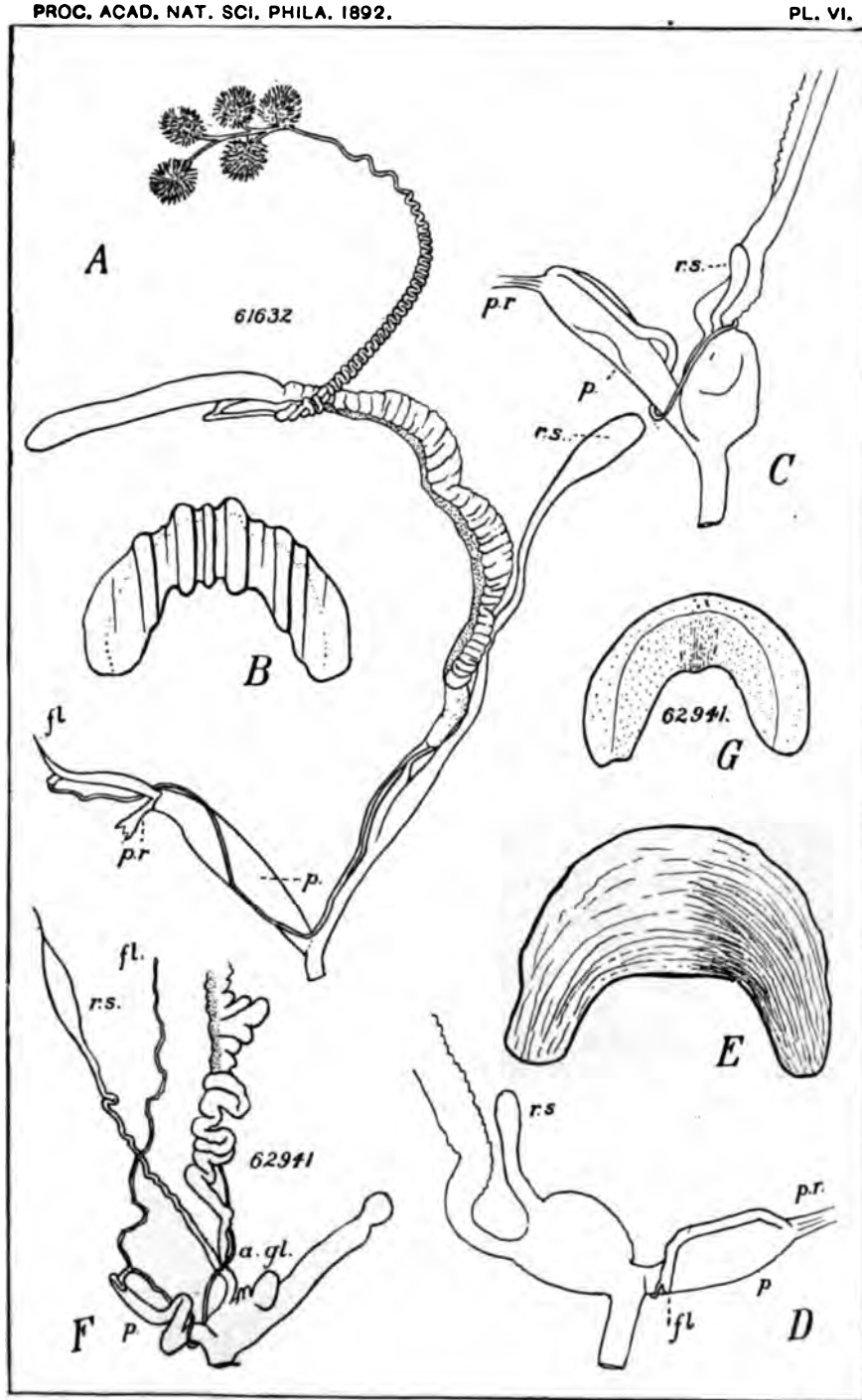
PILSBRY, ANATOMY OF CARACOLUS AND HEMITROCHUS.

PILSBRY, NEW UNIOS, ETC.



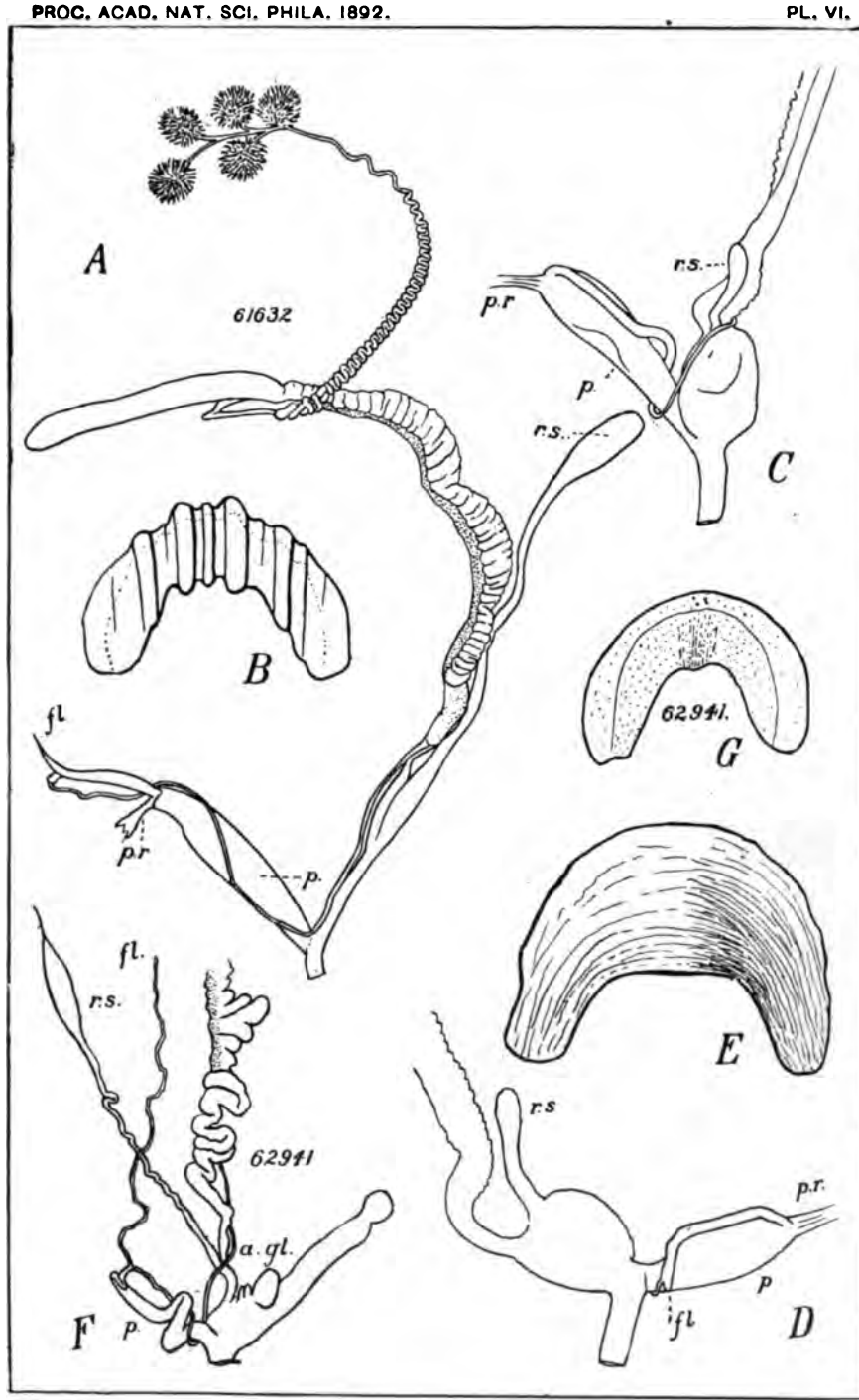
Banks, del.

BANKS, SPIDERS OF UPPER CAYUGA BASIN.



Pilsbry, del.

PILSBRY, ANATOMY OF CARACOLUS AND HEMITROCHUS.

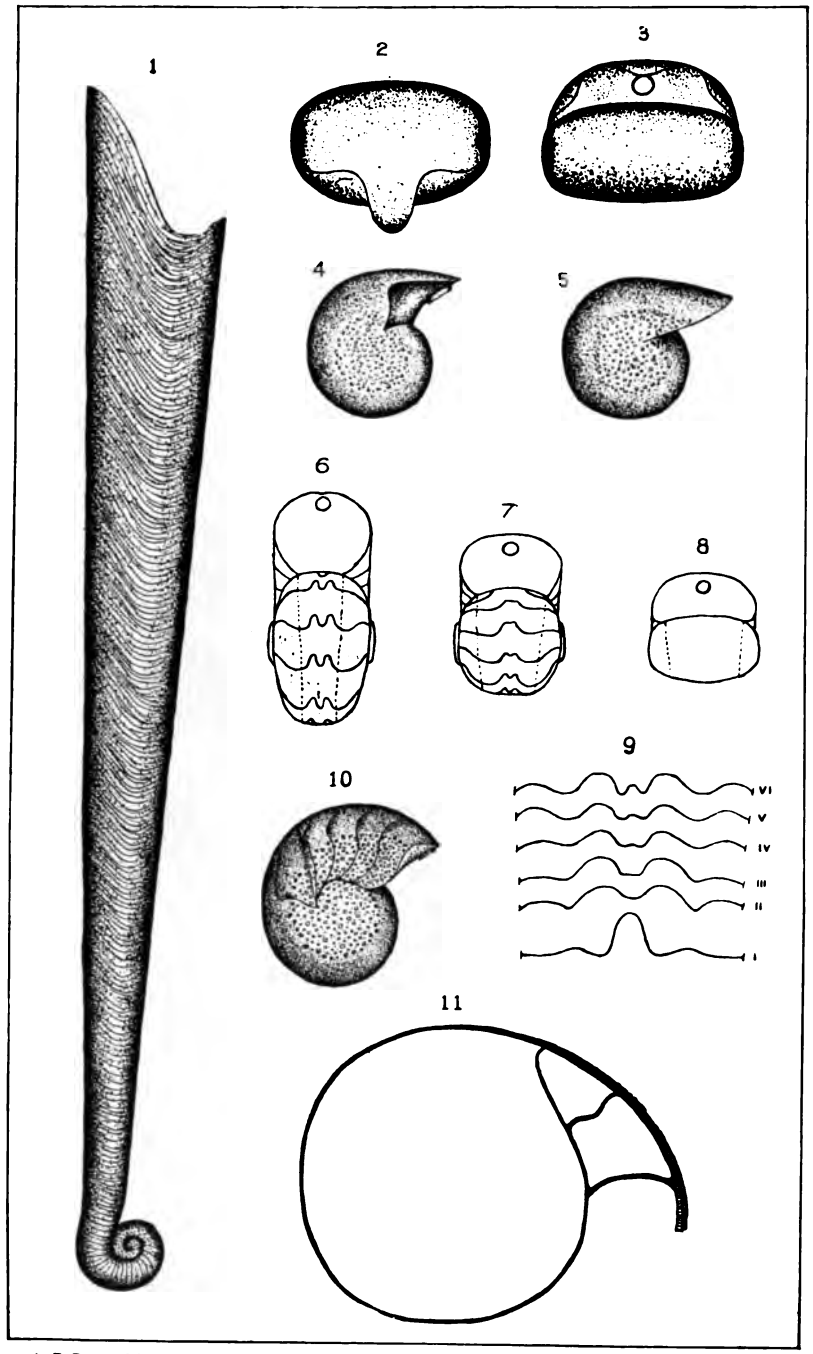


Pilsbry, del.

PILSBRY, ANATOMY OF CARACOLUS AND HEMITROCHUS.

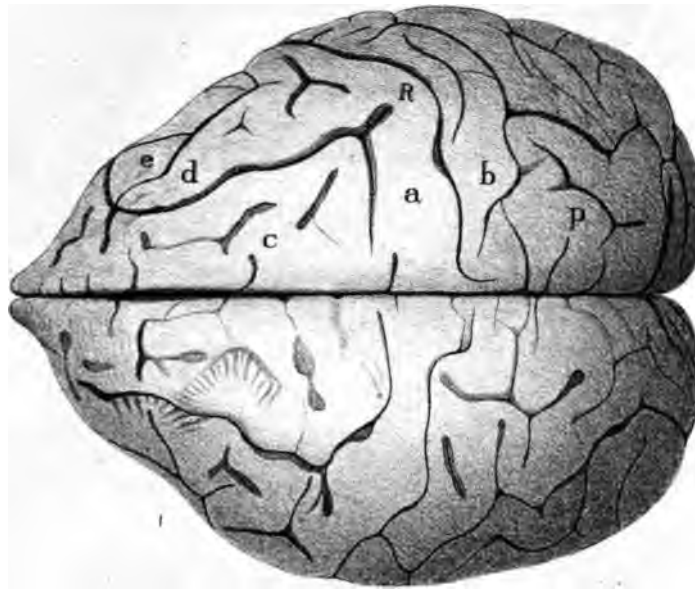
PILSBRY, NEW UNIOS, ETC.

PILSBRY, NEW UNIOS, ETC.

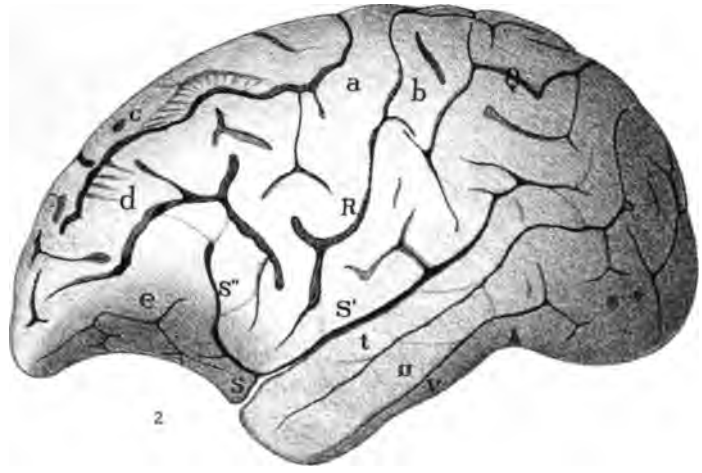


A. P. Brown, del.

BROWN, SPIRE OF BACULITES.



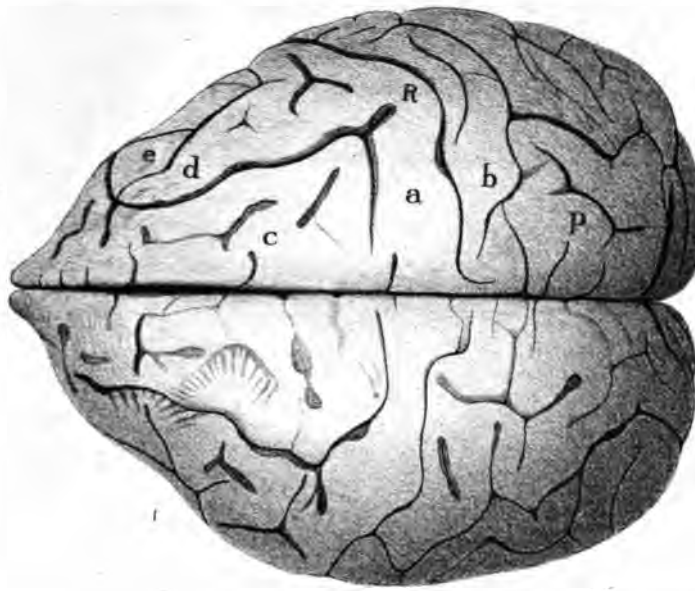
1



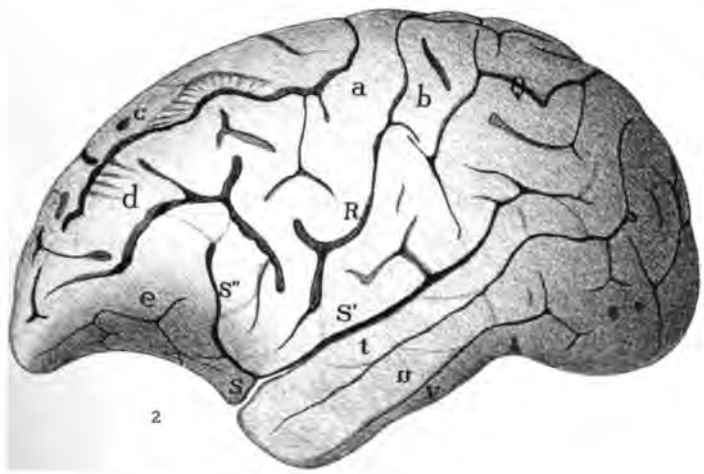
2

Geo. S. Harris & Sons Lith. Phila

CHAPMAN. BRAIN OF GORILLA.

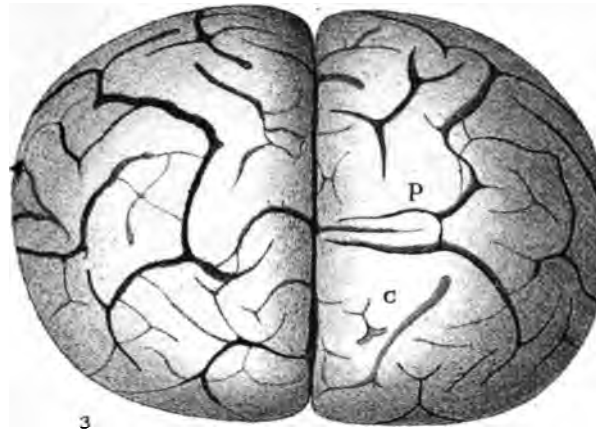


1

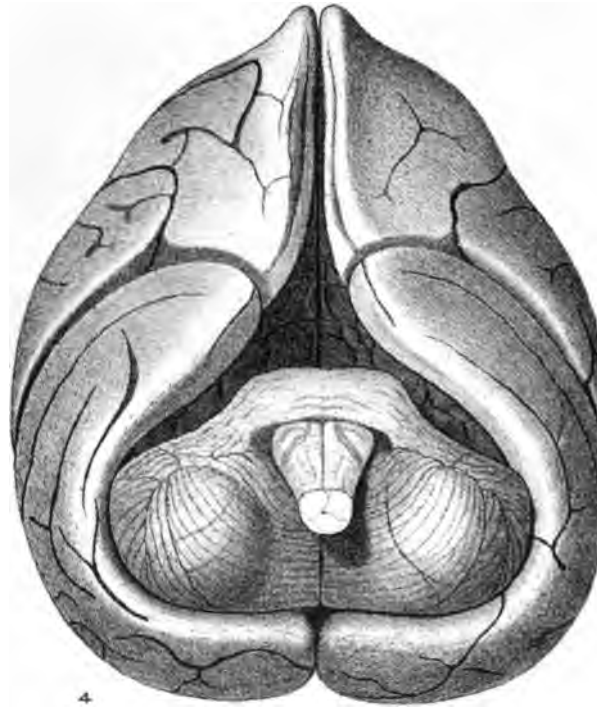


Geo. S. Harris & Sons Lith. Phila.

CHAPMAN, BRAIN OF GORILLA.



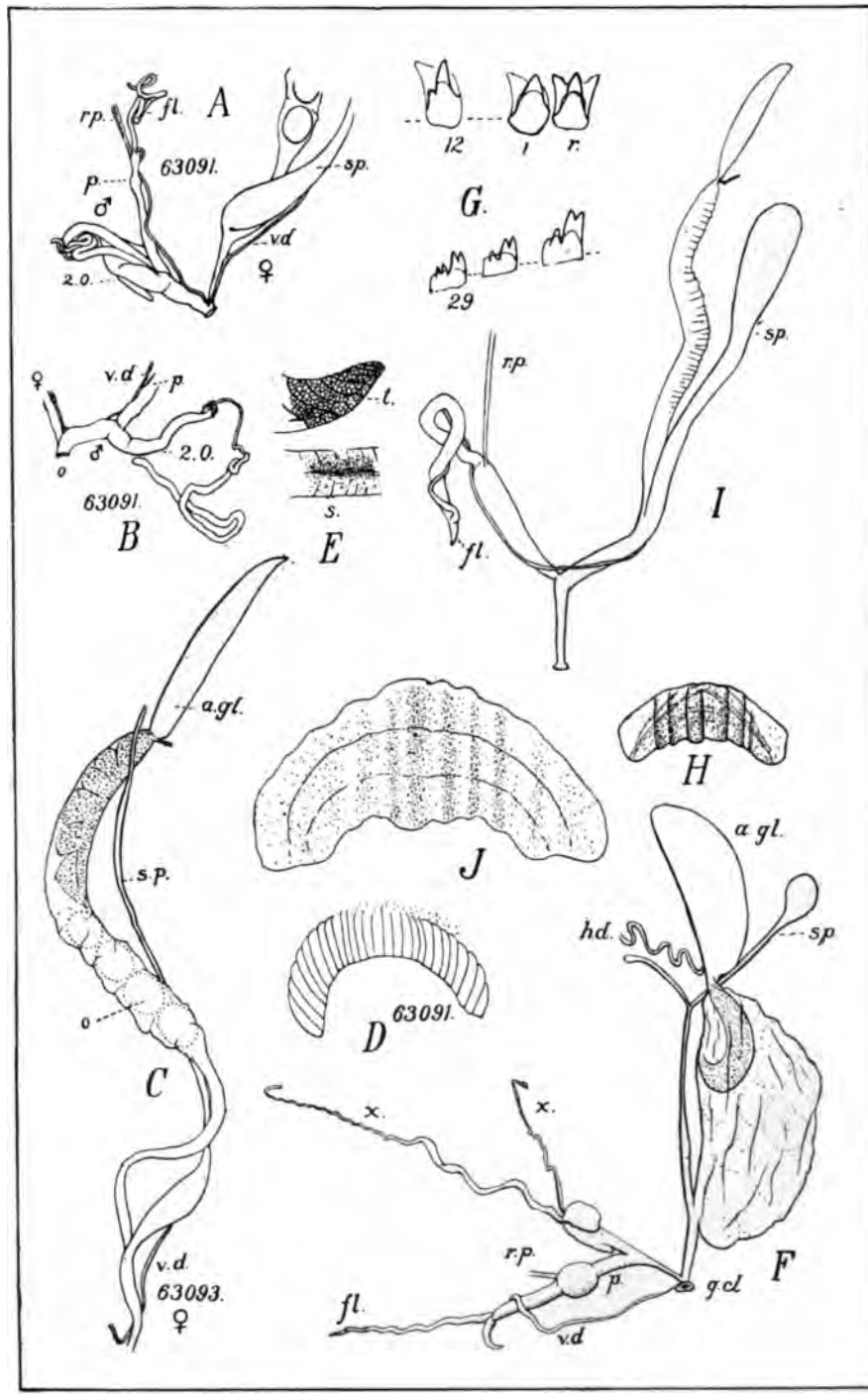
3



4

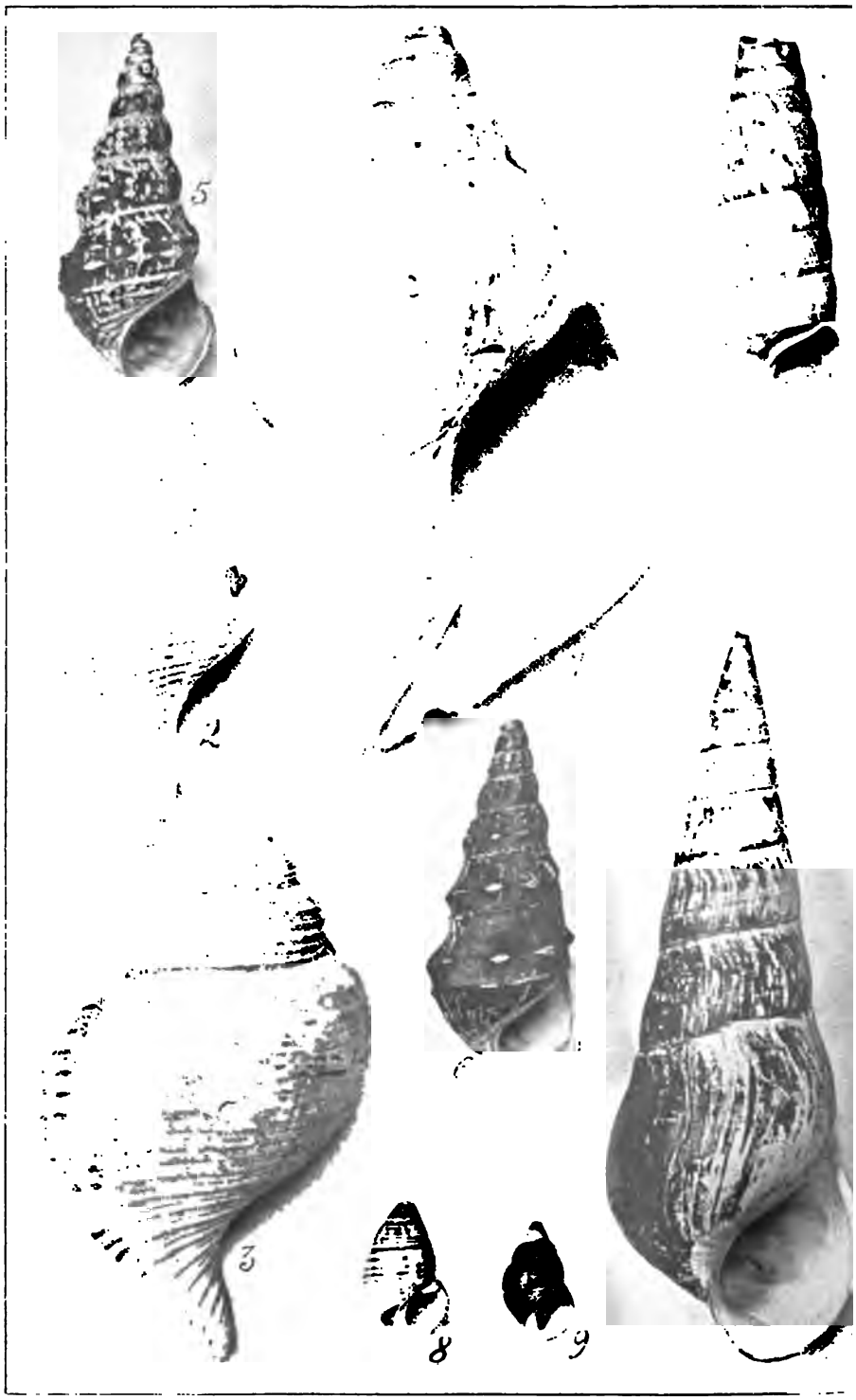
Geo. S. Harris & Sons Lith. Phila.

CHAPMAN. BRAIN OF GORILLA.



Pilsbry, del.

PILSBRY, ANATOMY OF SAGDA, CYSTICOPSIS, ETC.



PILSBRY, TABASCO MOLLUSCA, ETC.

PROCEEDINGS

OF THE

Academy of Natural Sciences

OF

PHILADELPHIA.

1892.

PART III, OCTOBER—DECEMBER.

PUBLICATION COMMITTEE.

JOHN H. REDFIELD, REV. J. NOLAN, M. D.,
THOMAS MEEHAN, ANGELO HEILPRIN,
CHARLES E. SMITH.

EDITOR: EDWARD J. NOLAN, M. D.

PHILADELPHIA:
ACADEMY OF NATURAL SCIENCES,
LOGAN SQUARE.
1892.

PROCEEDINGS

OF THE

Academy of Natural Sciences

OF

PHILADELPHIA.

1892.

PART III, OCTOBER—DECEMBER.

PUBLICATION COMMITTEE.

JOHN H. REDFIELD, EDW. J. NOLAN, M. D.,
THOMAS MEEHAN, ANGELO HEILPRIN,
CHARLES C. SMITH.

EDITOR: EDWARD J. NOLAN, M. D.

PHILADELPHIA:
ACADEMY OF NATURAL SCIENCES,
LOGAN SQUARE.
1892